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THE VALUE OF THE MENISCUS SIGN IN THE ROENTGENOLOGIC DIAGNOSIS OF ULCERATING GASTRIC CARCINOMA[1]

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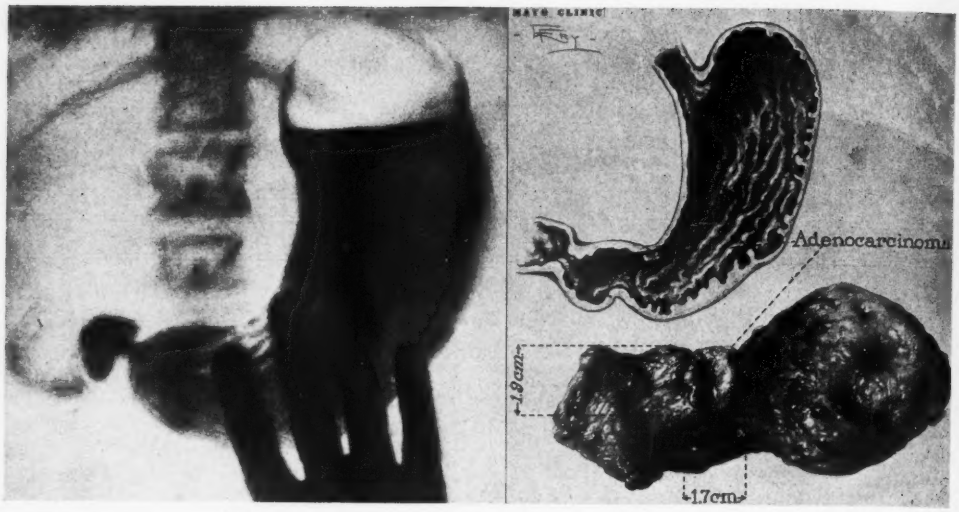
WITH improved apparatus, advances in technic, and information easily to be gained from the recorded experience of his co-workers, the roentgenologist is now properly expected to examine the stomach with almost the same precision as that possible with direct vision and to find the most minute lesions. He is, likewise, expected to carry his differential diagnosis constantly farther, and especially to distinguish benign from malignant disease with a closer approach to accuracy. In view of the importance of this particular distinction, I wish to direct attention to a differential sign which is usually reliable.

In 1921 Carman described a new roentgenologic sign of ulcerating carcinoma of the stomach, a concavo-convex shadow representing the ulcer crater, which he termed "the meniscus sign." Prior to this, Viennese roentgenologists had pointed out that in ulcerating carcinoma the cavity produced by the ulceration is usually situated well within the normal confines of the gastric lumen, and thus contrasts with the crater of a benign ulcer, which is sculptured as a niche in the gastric wall and invariably projects beyond the normal limit of the lumen. No great stress was laid on this mark of distinction, and the appearance of the crater itself was not considered, for ordinarily the most striking feature of frankly tumefying carcinoma is the resulting gross defect in the gastric shadow, and the form and situation of the excavation produced by sloughing are scarcely important.

Carman, however, had in mind carcinomas in which the element of tumefaction is much less obvious than that of ulceration and of which the character is less readily recognized. Morphologically, these lesions, although not mere ulcers, are essentially ulcerous rather than tumorous, and unless care is exercised, the roentgenologist may confound them with benign ulcers. The pathologist often can identify them grossly as carcinomas, because they are characterized by slightly elevated, irregular, overhanging borders uneven floors, and no tendency to perforate the wall. Carman found that these morbid anatomic features can be discerned with the roentgen rays and the entire picture is so definite that he regarded it as pathognomonic.

When the lesion is on or near the lesser curvature in the vertical portion of the stomach the crater is seen roentgenoscopically under palpatory pressure as a crescentic shadow, with its convexity directed outward, and the term "meniscus" aptly applies to it. When the lesion is on the lesser curvature distal to the angular

[1] Read before the Radiological Society of North America, at the Eighteenth Annual Meeting, at Atlantic City, N. J., Nov. 28–Dec. 1, 1932.



Figs. 1-*A* and 1-*B*. 1-*A* (*left*), Roentgenoscopic view. The meniscus complex on the lesser curvature is seen between the tips of the examiner's index and middle fingers. 1-*B* (*right, above*), Stomach, with lesion *in situ*. (*Right, below*), Specimen with lesion.

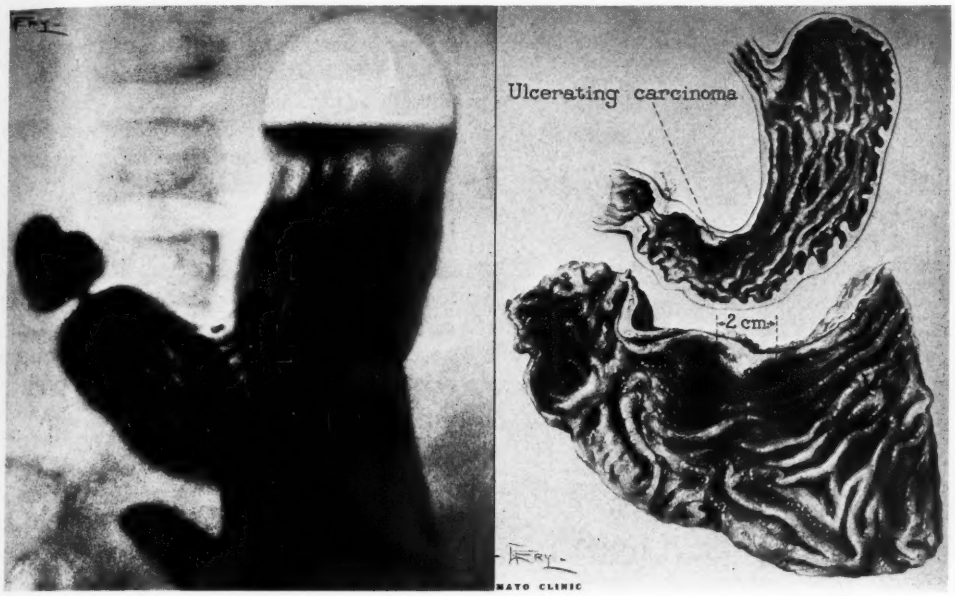
incisura, the base of the crater bends with the wall and the meniscus is concave above. If the ulcer is on the posterior wall, the crater appears, under manual pressure over the stomach, as a dense, irregularly rounded shadow encircled by a transradiant zone which corresponds to the elevated border.

At the Mayo Clinic the diagnostic value of the meniscus with its attendant phenomena has been abundantly proved, and I feel that it is worthy of renewed emphasis. In every surgical case in which these manifestations are elicited an ulcerating carcinoma has been found at operation.

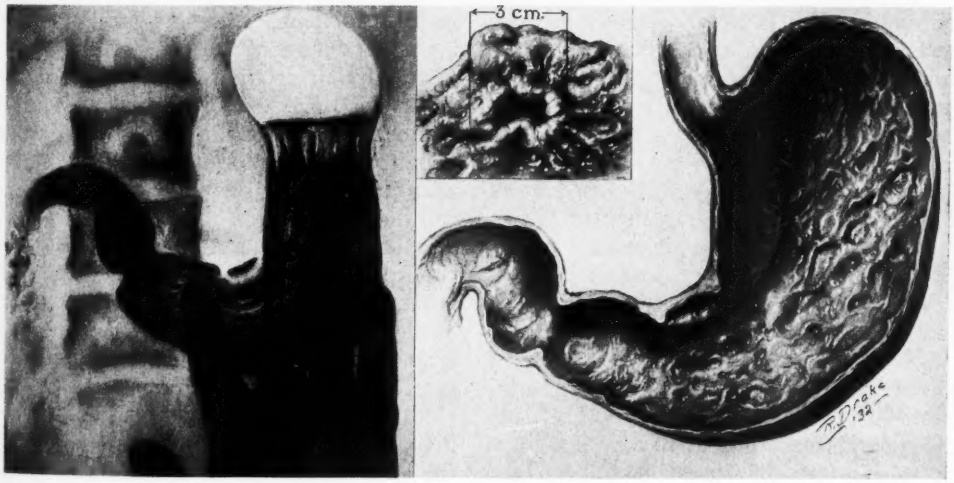
Although the meniscal form of the crater as seen in typical cases is important, it seems to me that the slightly raised, overhanging border is even more significant. When the pressure necessary to demonstrate it is exerted over a lesion of this character on the lesser curvature, the barium-filled crater is separated from the barium in the stomach by a clear zone which represents the approximated overhanging border of the ulcer. Similarly, when the lesion is on the posterior wall, the marginal ridge surrounding the crater is depicted as an encircling transradiant zone. In either instance the zonal defect is quite as striking as the shadowed crater and distinguishes the lesion from benign ulcer, which seldom has a raised or overhanging border. Another mark of the meniscus-crater is its slowness in emptying under pressure, and for this the marginal shelf is also responsible.

Certain other features aid in distinguishing ulcerating gastric carcinoma from simple ulcer: If the crater is visible tangentially as a niche, which is rarely the case, it does not project beyond the normal boundary of the lumen; the rugæ about it are obliterated, not accentuated and convergent as in benign ulcer; occasionally the base of the ulcer has a somewhat irregular profile; in the mesial view a crater on the posterior wall usually has an irregular margin; spastic phenomena are notably absent; the lesion is not tender on pressure, and may be palpable if it is sufficiently large and the abdominal wall is thin and lax.

Ulcerating carcinoma has a decided predilection for the lesser curvature distal to the angular incisura, and on compression the crater often assumes the form of a slit, with its long axis aligned with the



Figs. 2-*A* and 2-*B*. 2-*A* (*left*), Roentgenoscopic appearance of meniscus on lesser curvature, almost identical with that shown in Figure 1-*A*. Duodenal bulb deformed by an ulcer. 2-*B* (*right, above*), Stomach, with ulcerating carcinoma on lesser curvature. (*Right, below*), Segment containing lesion.



Figs. 3-*A* and 3-*B*. 3-*A* (*left*), Roentgenoscopic appearance of meniscus on lesser curvature; somewhat larger than in preceding cases. 3-*B* (*right*), Ulcerating carcinoma *in situ* and in excised specimen.

curvature. Barium pent up in a deep sulcus between hypertrophied rugæ has a similar appearance but can easily be dislodged. Benign, indurated, saddle-ulcer on the distal part of the lesser curvature differs from ulcerating carcinoma in that the niche of the former projects prominently and its base is convex above, where-

Fig. 4. Meniscus on lesser curvature and, above in insert, resected specimen.

as the crater of an ulcerating carcinoma in this situation does not protrude conspicuously, if at all, and its base is concave above.

To demonstrate these lesions and determine their character, roentgenoscopic examination under manipulation is indispensable. After the stomach is filled with the mixture of barium the lesions are likely to be concealed so completely that they are not visible in the roentgenogram and sometimes are not readily shown even by compressing the stomach. Accordingly, inspection should begin when the first swallow of barium enters the stomach, and the mixture should be distributed over the gastric walls by palpatory pressure to exhibit the entire mucosal relief. If an abnormality is seen, the patient may be allowed to take additional quantities of barium slowly, if the examiner so desires, but not to distend the stomach. By a downward-stroking pressure of the examiner's hand, the meniscus complex of crater and encircling ridge can be seen clearly above or between the outspread fingers. The complex is demonstrable not only when the lesions are moderately large but also when they are quite small, as shown by the following cases observed within a year, in all of which the diagnosis rested wholly on this combination of signs.

In the first case, that of a man aged 73 years, roentgenoscopic examination revealed a minute meniscus on the lesser curvature, below the angular incisura (Fig. 1-*A*). The diagnosis was small ulcerating carcinoma on the lesser curvature below the angle of the stomach. On surgical exploration the lesion could not be discerned until the lesser peritoneal cavity was opened to permit inspection of the posterior gastric wall. It was seen then as a small, flat growth on the posterior wall near the lesser curvature. Balfour-Polya resection was performed. The pathologist's report was adenocarcinoma graded 2, 1.9 cm. by 1.7 cm. by 7 mm., with beginning shallow ulceration (Fig. 1-*B*). In his notes, the surgeon stated that the patient had one of the smallest carcinomas that had been diagnosed.

The second patient was a man aged 74 years. On physical examination a firm, nodular, somewhat movable mass about 5 by 15 cm. was felt in the upper portion of the abdomen. Roentgenoscopy of the stomach disclosed a very small meniscus on the lesser curvature, at the angle, and definite deformity of the duodenal bulb (Fig. 2-*A*). The diagnosis was early ulcerating carcinoma of the stomach and duodenal ulcer. Neither diagnosis accounted for the palpable mass, and the patient was returned for roentgenoscopy of the colon. This revealed an obstructive lesion near the hepatic flexure, apparently associated with intussusception. On exploration, the surgeon found: (1) an invaginated tumor, grossly carcinoma, of the cecum; (2) a duodenal ulcer, and (3) a small tumor, probably malignant, on the lesser curvature 3 inches (7.5 cm.) above the pylorus. Hemicolectomy was performed, with the expectation of operating on the stomach later if the patient survived. The cecal tumor proved microscopically to be a papillary adenocarcinoma. Two weeks later the patient died

of pneumonia. Necropsy confirmed the presence of the duodenal ulcer and the ulcerating gastric carcinoma (Fig. 2-*B*). The latter was 2 by 1.7 cm. in dimensions and of the adenomatous variety.

In the third instance, that of a man aged 31 years, the lesion was a shallow ulcer, 1.5 by 3 cm., situated on the lesser curvature just below the angle. In consideration of the meniscus sign, the roentgenologic diagnosis was ulcerating carcinoma (Figs. 3-*A* and 3-*B*). At operation, the surgeon found it difficult to believe that the lesion was other than a simple ulcer with an inflammatory zone about it; from macroscopic inspection the pathologist likewise inclined to the opinion that it was not malignant (Fig. 3-*B*). Microscopically it proved to be adenocarcinoma.

The fourth patient was man aged 70 years. On roentgenologic examination a small meniscus was apparent on the lesser curvature, slightly distal to the angle, and the diagnosis accordingly was ulcerating carcinoma (Fig. 4). When excised by the surgeon, the lesion, which was 1 cm. in diameter, had the appearance grossly of a benign ulcer, but microscopically it was found to be an adenocarcinoma graded 3.

In each of these cases the meniscus was so small that it would not have been demonstrable without close adherence to a routine roentgenoscopic technic. Even when the lesions are considerably larger, careful and methodical examination is requisite to disclose them. Especially necessary are three technical features, namely, to begin roentgenoscopic inspection when the first swallow of barium is taken, to distribute the bolus of barium and its successors over the wall of the stomach by manipulation, and to study the internal gastric relief while it is being revealed by downward stroking pressure of the examiner's fingers. To accomplish these maneuvers successfully it is imperative that the patient's abdominal wall be completely relaxed. Critical examination of the internal surface of the stomach was introduced long ago by Holzknecht and is widely employed. Observance of this detail apparently has not been universal, however, for roentgenography of the mucosal relief, now being emphasized by European roentgenologists, has been regarded by many as fundamentally new. Roentgenograms for permanent record are often desirable, but roentgenoscopic scrutiny of the gastric internal topography is basic, and the most trustworthy method of discovering narrowly limited organic changes.

REFERENCE

(1). CARMAN, R. D.; New Roentgen-ray Sign of Ulcerating Gastric Cancer. Jour. Am. Med. Assn., Sept. 24, 1921, LXXVII, 990–992.

CARCINOMA OF THE LIP AND MOUTH[1]

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THE literature produced by the larger cancer centers allots a rôle of ever-increasing importance to irradiation in the treatment of lesions in and about the mouth, but the average practitioner of medicine, whose judgment is based on his personal experience, is in most instances quite unconvinced of its value. Nor is he always to be condemned for his attitude, since his radiological confrères, especially those located at a distance from the large cities, are too frequently inclined to use inefficient methods, assuming perhaps that they cannot afford to equip themselves with the necessary apparatus needed for better results.

It is the author's opinion that quite creditable work may be done with equipment of modest proportions, and this article is written in an effort to stimulate the interest of those radiotherapists who are not connected with large, richly endowed institutions. Their good work, displayed before their medical colleagues, will mold medical opinion as no amount of writing can possibly do.

Carcinomas of the lip, mouth, and pharynx are, with few exceptions, of the squamous-cell variety, and, generally speaking, it may be stated that efficient treatment must be designed to take care of that kind of malignancy. Experimental work and clinical observation have evolved certain principles which should, when possible, be followed. They are:

1. Six to twelve erythema doses of irradiation are needed for the actual cure of squamous-cell carcinoma.

2. Recovery is more rapid and surrounding normal tissues show a quicker return to normal when the treatment is administered over a prolonged period, usually from seven to fourteen days.

3. Short wave lengths produced by heavy filtration lessen the injury to surrounding normal tissues but are not essential in treating superficial lesions on the lip.

4. An attempt should always be made to produce a cure with the first series of treatments, since the second attempt is never so successful and may produce injurious effects.

5. Infection and irritation (tobacco, bad teeth, etc.) interfere with healing and must be eliminated during treatment.

Since the therapy accorded primary lesions is quite different from that used for metastases in the neck, the first portion of this paper will deal entirely with the primary conditions and the management of the neck will be taken up later.

CANCER OF THE LIP

Carcinoma of the lip is an accessible, easily recognized lesion which metastasizes very late. Any method of treatment which thoroughly eradicates the primary lesion will, therefore, produce a large number of cures, and the surgical statistics are universally good. However, both x-rays alone and radium alone have, in the hands of those therapists possessed of enough courage to give ample dosage, brought about equally good results. Unfortunately almost every surgical clinic has seen many cases treated by the overcautious radiologist who slowly feels his way along, giving one or two erythema doses and then waiting a few weeks to see what happens. After a few months of this therapy the lesion frequently becomes so radioresistant that radiation is no longer effective, and the surgeon who is finally called in cannot understand why he was not consulted in the beginning. This conservative attitude in radiation therapy has

[1] Presented before the American Congress of Radiology, at Chicago, Sept. 25–30, 1933.

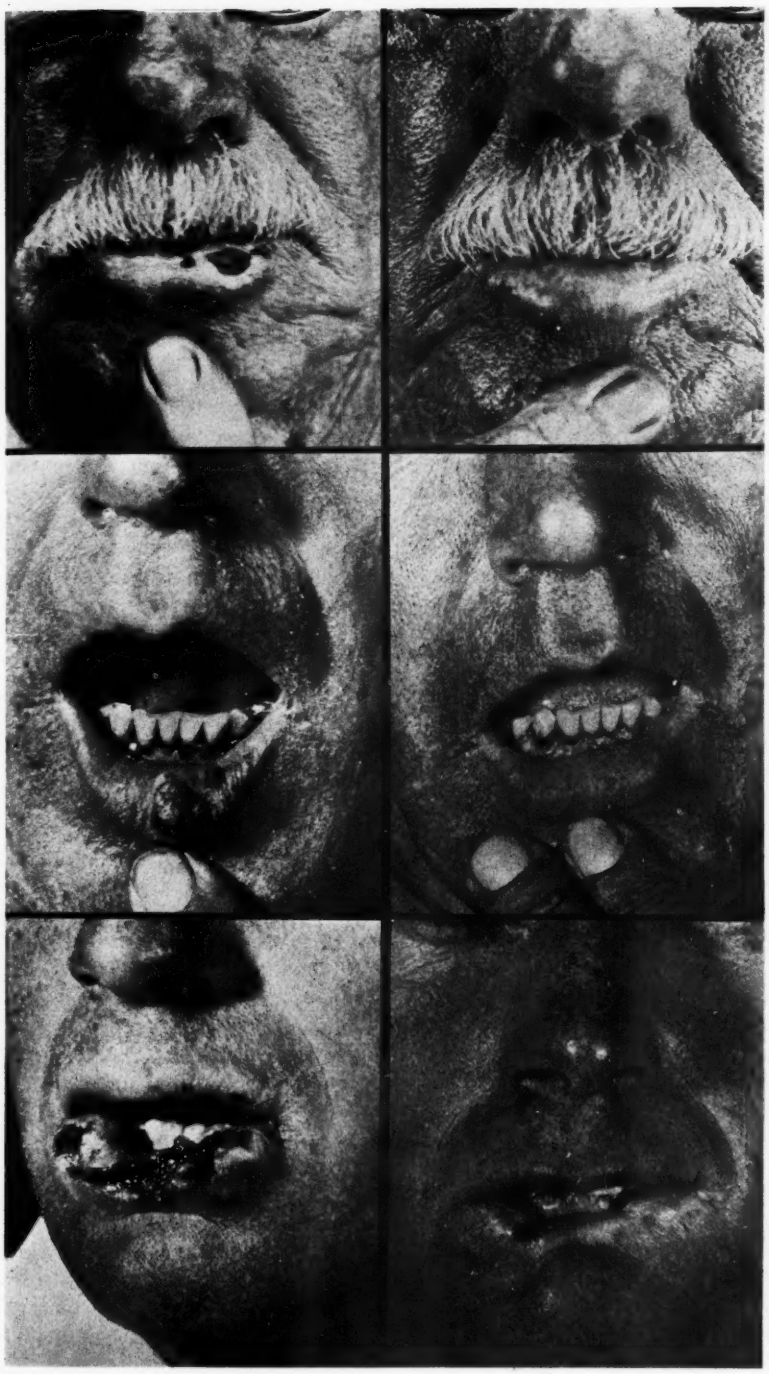

Fig. 1. Cancers of the lower lip, all of which have remained well for three years or more. Treatment consisted of x-rays alone in each instance.

been sponsored largely by the dermatological literature, which, almost without exception, recommends doses that are entirely too small to produce a cure.

Most carcinomas of the lip which do not extend into the mucous membrane of the cheek and which have not been treated previously with radiation, respond quite satisfactorily to from six to twelve minimum erythema doses of long wave length x-rays. The cosmetic results are very good indeed and the method is an economical one, since neither hospitalization nor expensive radium applicators are necessary. This technic was developed by Pusey (1) more than twenty years ago, but for some reason it has never come into general use.

Our plan of treatment has been published in previous articles (2, 3, 4) and will not be elaborated here. Suffice it to say that one or two erythema doses of lightly filtered x-rays generated at a low voltage are administered to the lesion and immediately adjoining tissues every day or every other day until from six to twelve erythema doses have been given. A marked reaction occurs but complete healing usually is obtained in from six to eight weeks. In 1931, statistics were published covering 119 traced cases treated from 1906 to 1925. Eleven of these patients had glands in the neck at the time of treatment and they are all dead: this leaves 108 cases that had no palpable glands at the time of treatment. Of this group, 104 have remained well without visible evidence of the disease for five years or longer—many have been well for more than ten years and one for thirteen years. The four that died had definite recurrences in the glands. In this series, then, 96.3 per cent of the patients without demonstrable extension into the lymphatic system have remained well for five years or longer.

A recent survey of a similar group treated from 1925 to 1928 shows 41 patients out of 42 alive at the end of five years, one dying of a recurrence in the glands of the neck. Two cases in this series had stubborn local recurrences which were treated surgically, with good results. It is only fair to say that most of the lesions in this latter survey were of moderate size and, therefore, favorable for treatment. This may be attributed to the fact that the radiologic method has become well known in our vicinity as a simple procedure which usually cures cancer of the lip without operative interference. Watchful waiting is never so frequent when the proposed treatment is non-surgical.

Exception is frequently taken to our statistics because, in most instances, no histologic studies are made. The clinical diagnosis of carcinoma of the lip is a relatively easy one to make and those who have viewed our patients or their photographs rarely question the diagnosis. It is our feeling that the best cosmetic results cannot be obtained, particularly in small lesions, when tissue is removed, and since the biopsy may also favor metastases the procedure is usually omitted in lip cases. The rapid disappearance of the tumor under treatment is in itself a valuable diagnostic test, since benign lesions do not as a rule show this response.

Lip lesions which previously have been subjected to a long series of ineffective x-ray treatments do not receive the technic just described. When there is no visible irradiation effect or the reaction is of a moderate degree weak radium needles are implanted under the edges of the tumor for a period of seven days. This technic will be described in detail under the heading of Intra-oral Carcinoma. It requires hospitalization and may produce some scarring, but it is usua'ly quite effective. When the treated area shows a smoldering treatment reaction which has not healed in a reasonable period, radical excision of the involved region offers the best chance of a good result.

Carcinomas arising on one side of the lip sometimes extend out onto the mucous membrane lining the cheek and involve the corner of the mouth in such a manner that the x-ray cone cannot be applied directly to all the lesion. In such cases weak radium needles are sewed under the

edges of the inaccessible portions of the tumor for a period of seven days, while the accessible portion is treated with the regular x-ray technic. This combined plan has proved quite satisfactory in that it produces little deformity of the corner of the mouth and the mucous membrane is restored to a practically normal condition.

INTRA-ORAL CARCINOMA

Intra-oral carcinoma is a much more difficult problem than lip carcinoma, because metastases of a stubborn type occur quite early. No plan of treatment has yielded a high percentage of cures, but radiation has become the method of choice in hospitals where it is available, because of its relative simplicity and the good cosmetic results which it frequently yields.

Radiologists are all familiar with the good work done by Quick and his coworkers at the Memorial Hospital with gold radon seeds. However, these implants are immediately available in only a few centers outside of New York City and in most localities they must be ordered from New York if they are to be obtained at all. A worthy substitute is, therefore, highly desirable in the more distant communities.

Regaud (5) has, during the past ten years, advocated the use of heavily filtered platinum radium element needles of low intensity for intra-oral malignancies, and his technic has been further elaborated by Cade (6), Ward and Smith (7), Birkett (8), and others in London hospitals. This method has certain disadvantages in that it necessitates hospitalization for seven or eight days, and it cannot be used in regions which are difficult of access such as the posterior nasopharynx, where radon seeds may be placed with specially constructed trocars. However, it is an efficient, relatively economical procedure which reduces sloughing and secondary reactions to a minimum, and it may be carried out in any standard operating room.

Our needles are all constructed of platinum-iridium and have wall thicknesses of 0.5 and 0.6 millimeter. There are three different sizes which have active lengths of 1, 2, and 4 cm., respectively, and the radium element is evenly distributed throughout each needle so that there is 0.6 mg. contained in each centimeter of active length. This method of loading was adopted after it was found that 0.6 mg. of radium in a 1.0 cm. needle could destroy 1.0 cubic centimeter of squamous-cell carcinoma when it was centrally placed for a period of seven days. In effecting implantations an effort is always made to insert the needles beneath and around the edges of the tumor so that they are spaced about 1 cm. apart. They may be placed radially or in parallel patterns, and in intra-oral work each needle must be stitched in place so that it cannot be lost or slipped out of position.

The details of the technic were given in a previous article (9). When a large mass occurs in the cheek, it is wise to sew a row of small needles around the edges of the tumor within the mouth and insert a series of long needles under the growth from an external approach. This carries out the general plan of thoroughly radiating the tumor bed and its growing edges, which apparently accounts for the success of the needle technic. Such a plan is more difficult of execution when the lesion appears in the tongue or floor of the mouth, but the attack is always aimed at the tissues surrounding the neoplasm when possible.

After the implantation is completed radiographs are made and the needle patterns are studied. If the distribution of the sources of radiant energy is not quite what it should be, a readjustment is made. Since success depends on a good pattern this procedure is a most valuable one. Perhaps the greatest disadvantage of radon seeds is the fact that they cannot be readjusted after they are once inserted into the tumor. It is also found rather difficult to place these tiny structures with the precision that can be attained with

the needles, the location of which is indicated by anchor stitches.

During the time that the radium remains in place the patient stays in the hospital, although he is usually not confined to bed for more than one or two days. A rigid system of oral hygiene is observed, the mouth being washed out frequently with antiseptic solutions. The involved region is also painted at least three times daily with 2 per cent mercurochrome. The diet consists for the most part of a liquid 2,000-calorie formula, augmented at intervals with small amounts of fruit

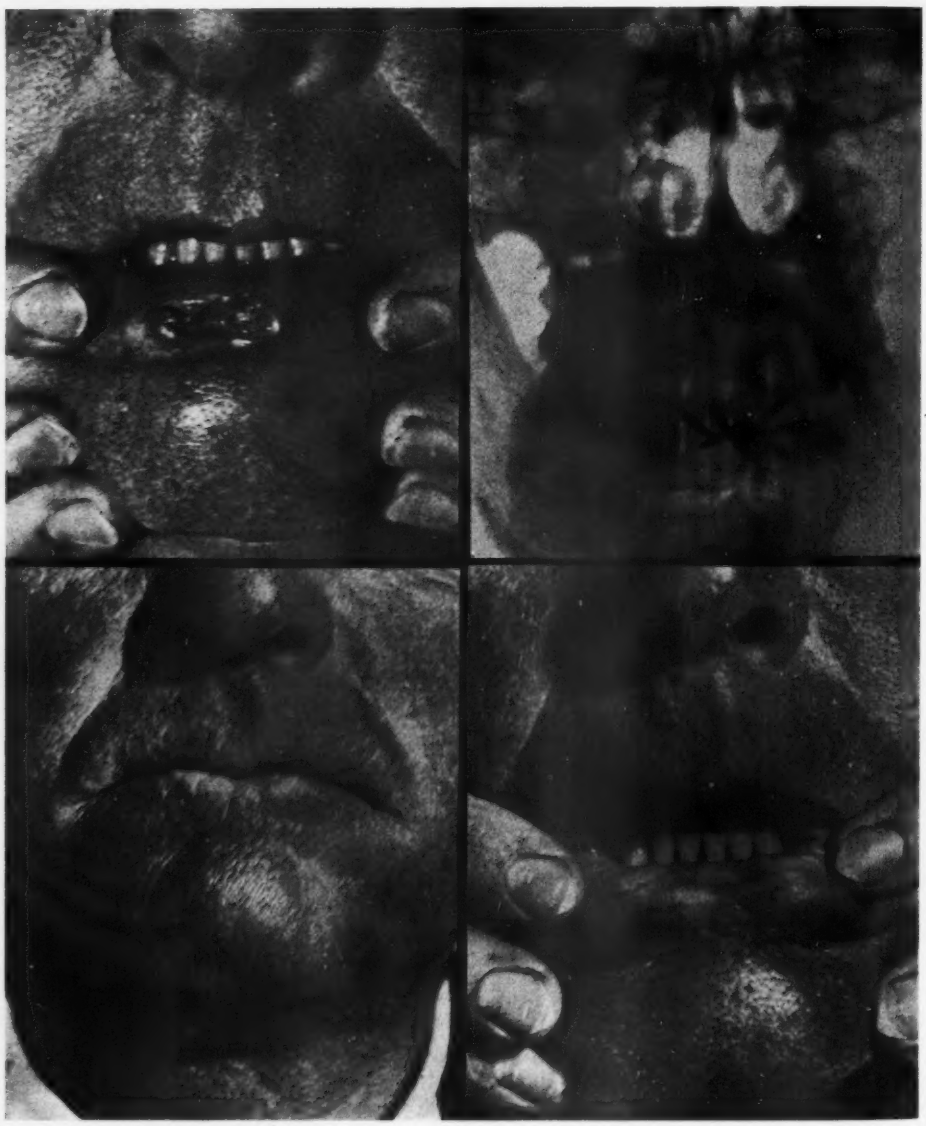

Fig. 2. Squamous-cell carcinoma of lower lip insufficiently treated with x-rays. Healing was obtained with weak radium needles but the cosmetic result was not so good as that obtained with x-rays.

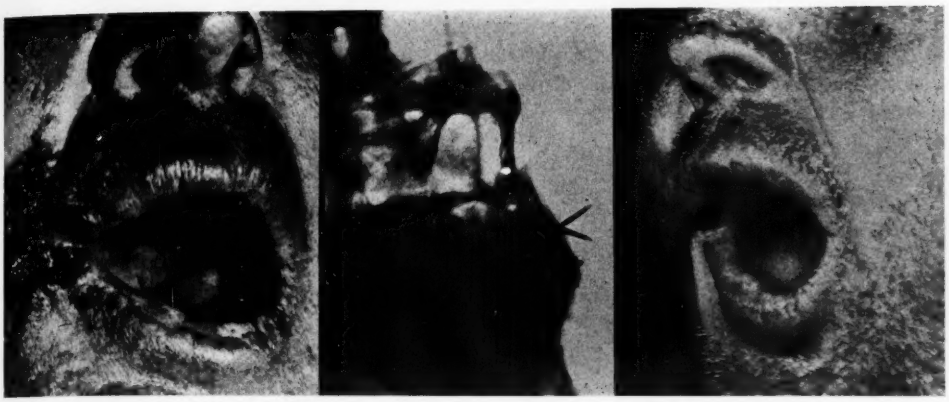

Fig. 3. Carcinoma involving corner of the mouth. The external lesion was treated with x-rays, and weak radium needles were used in the corner of the mouth with the result shown on the right.

juice. Although codeine is ordered for all cases it is rarely needed after the second or third day.

At the end of seven days, when the anchor stitches are clipped and the needles are removed, some shrinkage of the tumor is frequently seen. After about two weeks the mucous membrane in the treated region takes on a grayish color. Although at first glance a slough appears to be forming, such is not really the case, because the reaction is limited to the superficial layers and is not accompanied by pain. In another two or three weeks the grayish membrane comes away, leaving pink granulation tissue beneath, and rapid healing usually follows. When the primary lesion is of moderate size the whole process requires about two months. Practically no scarring is observed when the tumor is small, and when scars do result they are soft and pliable and give little trouble afterward.

Many of the early workers constructed cumbersome lead shields which were worn in the mouth to protect the bony structures from the effect of the rays. We have found this precaution unnecessary and have on a number of occasions planted 0.6 mg. needles against the alveolar margins and the hard palate for seven days without producing necrosis in the bone. Hard palate implantations will invariably produce a superficial reaction on the tongue unless some protective apparatus is used, but these reactions heal readily, leaving little evidence of their presence.

Since this work was started in our laboratory in a very limited way about three years ago we have no three- to five-year statistics available. However, a brief survey of our material may be of some interest. Our cases have been unselected and represent a rather unfavorable group, coming for the most part from the rural districts. Forty such patients have been treated, but three of them can no longer be located, leaving a group of 37 that have been traced. Thirty of these cases were treated more than one year ago and a study of their progress is of some value. The primary lesions varied from one-half to three inches in diameter, but only two measured less than three-quarters inch in diameter, and twenty measured one inch or more in diameter. Sixteen, or about half of the patients, had palpable lymph nodes in the neck at the time that treatment was instituted. Histologic studies showing squamous-cell carcinoma to be present were made in all of the cases except two, but the clinical diagnosis seemed evident in each instance. The pathologic department at Baylor University Hospital graded most of the tumors as I or II, but a few Grade III neoplasms were en-

countered. The primary lesions disappeared in all except two patients. One was an old, anemic man with a hard, deep ulcer in the cheek; the other a man who used tobacco and alcohol excessively soon after the treatment was given. Seventeen of the cases (56 per cent) have been alive for more than one year, and twelve (40 per cent) have shown no evidence of carcinoma for a year or more. Two of this latter group, one a carcinoma of the tongue and the other a carcinoma of the cheek, have remained well for a little more than three years.

The primary lesions have responded to treatment equally well, regardless of what

Fig. 4. Squamous-cell carcinoma of the cheek and alveolar margin, with a perforation through the cheek. Small needles were placed around the lesion and long needles were embedded in the cheek. The excellent internal and external results are shown below.

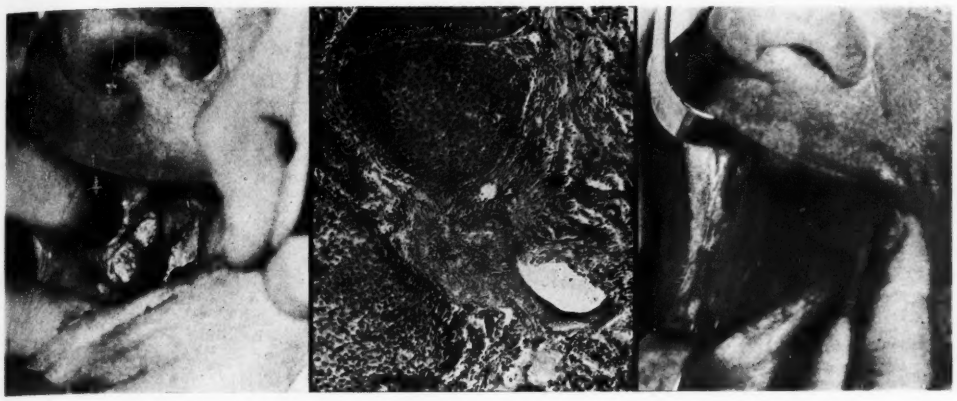

Fig. 5. Grade I squamous-cell carcinoma of the cheek treated with weak radium needles. The result on the right indicates that the lower grades respond as well as the higher ones.

the histologic grading might be. In fact, some of the Grade I tumors have shown as rapid a regression as any of the others. It is our impression, therefore, that grading is of little value except insofar as it indicates the probability of early metastases or the radiosensitivity of metastases which have already appeared.

One of our greatest problems has been the care of the patient, usually with an advanced lesion, who, several months after treatment, develops a recurrence in the treated area or adjacent to it. In the beginning these cases were again subjected to an extensive radium implantation, but almost without exception this procedure resulted in the formation of a deep slough, which often did not eliminate all of the diseased tissue and the ultimate result was usually most unhappy. If, as many think, primary resolution occurs as a result of the effect of radiation on the young blood vessels entering the malignant tissue, a second heavy dose may completely obliterate the blood supply, and this is what apparently happens. In one such case the side of the cheek and a large part of the neck fell away, leaving the mandible exposed. There was surprisingly little pain, and no evidence of carcinoma can be detected at the end of a year. However, this good result was exceptional and secondary implantations should most certainly be avoided when possible. For this reason the first needle pattern must be laid out with meticulous care so that the greatest possible regression may be obtained from it.

CARCINOMA OF THE PHARYNX

Mention has already been made of the difficulty encountered in using radium needles in the posterior portion of the mouth and in the pharynx. Fortunately, tumors located in these regions are as a rule quite radiosensitive. Martin and Pflueger (10) have recently shown that pharyngeal tumors are much more sensitive to radiation than their grading would indicate, and in some cases complete though temporary regression followed the administration of less than two erythema doses into the lesions. However, these same authors advocate a minimum of six erythema doses for the production of an actual cure.

External radiation is obviously more likely to be successful in cases in which the malignant tissue is not deeply situated and is quite radoisensitive, and Coutard's (11) good results in pharyngeal tumors (obtained with his massive divided dose x-ray technic) are, therefore, not surprising. Since his doses are given in terms of the amount striking the skin, an

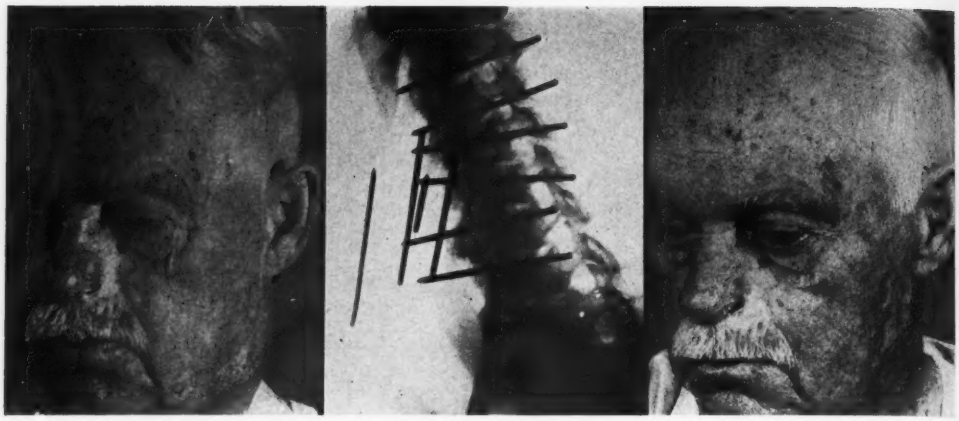

Fig. 6. Large mass of malignant glands in neck secondary to squamous-cell carcinoma of the skin. The embedding of long weak radium needles, together with radium packs and deep x-rays, produced in six weeks the appearance shown on the right.

estimation of his depth doses cannot be accurately made, but his results indicate that they are ample. Although his technic can be carried out in any laboratory equipped for deep therapy, it is a most time-consuming procedure and, therefore, not economical. In an effort to produce palliation in pharyngeal tumors we have, during the past year, used the Coutard plan with a filter of 0.75 mm. of copper and 1 mm. of aluminum, thereby cutting down the total treatment time appreciably. One-half erythema dose is given over the same area on the neck daily until ten or twelve such doses have been administered. In two to three weeks the neck shows a marked desquamation but no ulceration, and it seems evident that this dose might be safely increased. A patient having an extensive squamous-cell carcinoma involving one-half of the epiglottis and the side of the pharynx and larynx has remained apparently well for four months following this procedure. All visible evidence of the disease completely disappeared in two weeks, leaving the mucous membrane pink and healthy in appearance. Although this modified technic may not be curative it has a place in a busy clinic where an effort is made to do something for all types of patients.

CERVICAL ADENOPATHY

The outlook for patients with cancer in and about the mouth might be said to be most favorable now if some thoroughly efficient method of controlling metastases in the cervical lymph nodes could be devised. Various radical block operations have been elaborated, but the fact remains that striking success has been accredited to these procedures only in the cases in which no malignant invasion has yet appeared in the lymphatic system. It must be admitted, however, that a certain small number of favorable cases with cancer in the cervical lymph nodes have been cured by operation, whereas statistics claiming cures from radiation alone are indeed rare. The mechanism by means of which the regression of carcinoma in a lymph node is brought about seems to be quite different from that which operates in the primary lesion, probably because of the difference in the arrangement of the blood supply in the tumor bed. Although heavily filtered radiation when delivered in large doses causes the enlarged glands to shrink, recurrences are the rule.

For practical purposes all cases may be divided into three classes, namely, those having no palpable lymph nodes; those

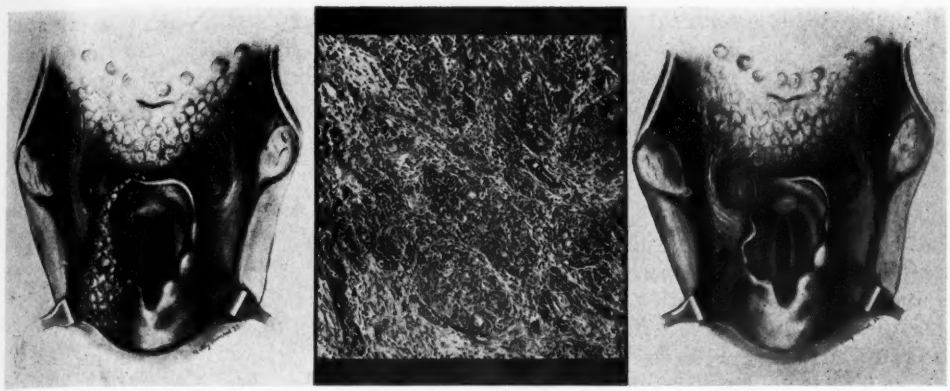

Fig. 7. Squamous-cell carcinoma Grade III involving larynx and pharynx. The result on the right was obtained by applying ten half erythema doses of deep x-rays to the left side of the neck on successive days.

having palpable nodes that are considered operable, and those having inoperable metastases in the neck.

The first group is the one over which most controversy arises. The surgeon who observes that a large number of the patients of this type who have block dissections get well is quite certain that a routine block should be done in every case. This attitude cannot be shaken, even though it has been shown that in most instances the material removed contains no malignant tissue. If this routine is to be adopted, it should be reserved for the intra-oral lesions, which usually involve the lymph nodes quite early. Carcinoma of the lip spreads to the lymphatic system at a much later stage of the disease and should, in our opinion, be handled in a more conservative manner. Our statistics (12), as well as those of Duffy (13), indicate that the number of cures obtained equals that accredited to the most radical surgical procedures, and the patients not only avoid the inconvenience of the operation but are not subjected to its added risks—a small factor but still worth considering. It is our custom to administer heavy external irradiation to the neck with deep x-rays and radium packs at the same time that the primary lesion is treated. The dosage is sufficient to cause a marked desquamation of the superficial layers of the skin. The patient is warned about the significance of enlarged cervical nodes and is asked to report back immediately upon discovering glands in the neck. When they appear later, and this is a rare occurrence in lip cases, a block dissection is recommended.

When the neck contains operable malignant lymph nodes at the patient's first visit, operation is advised. In this class of patients a difference of opinion frequently arises over what constitutes an operable case. Quick's (14) criteria are based on an ample experience and may be used as a guide. He considers that a case is operable which has a few freely movable glands that show no evidence of extension, have not broken through their capsules, and are situated on one side of the neck only. Patients having numerous glands, glands attached to underlying structures, and glands on both sides of the neck are not considered operable. When, at the time of operation, the surgeon feels that he may be leaving malignant tissue behind, radon implants or small platinum radium needles may be used in the suspicious regions. Of course, such cases are not really operable in the beginning, but in borderline cases it is sometimes difficult to accurately determine operability.

The inoperable cervical nodes are a radiological problem though not a very hopeful one. Although many radiologists

are opposed to interstitial radiation for such patients, our best results have been obtained with a combination of external and internal sources. Long platinum needles containing 0.6 mg. of radium per centimeter of active length are inserted beneath the involved nodes and well beyond them, at intervals of 1 to 1.5 cm., and left in place for seven days. A 100-mg. radium pack, having the radium placed in platinum capsules with 1 mm. walls, at a distance of 2. cm. from the skin, is then applied to the neck over the involved nodes and left in place for thirty-six hours. In addition, both sides of the neck from the upper jaw to the clavicle are given an erythema dose of x-ray generated at 200 K.V. and filtered through 0.75 mm. of copper and 1.0 mm. of aluminum at a 50-cm. target-skin distance. This plan produces a marked desquamation of the skin and a few areas may show a temporary superficial ulceration. However, in the course of four to six weeks the reaction subsides, leaving the skin soft and pliable and the malignant glands usually show a marked shrinkage. The patients show definite clinical improvement which may last for from four to six months and occasionally much longer.

SUMMARY

Technics are described which should enable a radiotherapist having a standard x-ray laboratory and a moderate quantity of radium available to produce creditable results in cancer of the lip and mouth.

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CHRONIC ARTHRITIS OF THE SPINE[1]

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UNDER this title, we include those non-specific arthritides whose origin is in dispute, and whose nomenclature and clinical differentiation have never found universal acceptance. These arthritides are often grouped under the name of "spondylitis deformans," especially those cases which exhibit deformity and various grades of rigidity. "Spondylitis ankylopoietica" is a name which is sometimes applied to those cases whose chief characteristic is ankylosis of the spine, usually due to ligamentous calcification. The etiology of this group is usually attributed to some obscure infectious agent.

We believe that from a study of the clinical features, together with the gross roentgen pathology, one can differentiate these cases still further. The classification given by Knaggs (1) seems to be clear-cut and the terminology bears a direct relation to the underlying pathology. This classification is as follows: I. *Spondylitis Ossificans Ligamentosa.*—This corresponds to the cases described by Marie and Strümpell and is usually considered as the spinal manifestation of atrophic arthritis; II. *Spondylitis Muscularis.*—This group is identical with the type described by Von Bechterew, who emphasized the muscular weakness and the nerve changes; III. *Spondylitis Osteoarthritica.*—The changes in this type represent the type of arthritis that is ordinarily designated as hypertrophic arthritis.

The subject matter of this communication is for the most part old, and we have no original contribution to make. Rather, we have gone back to the original articles of Marie (2) and Von Bechterew (3 and 4), attempting to get their point of view of the conditions that bear their names and to correlate this with our later knowledge, which is more largely derived from the roentgen examination.

SPONDYLITIS RHIZOMELIQUE—MARIE-STRÜMPELL ARTHRITIS

This type of ankylosing arthritis was first described by Pierre Marie (2) in 1898, who called it "spondylitis rhizomelique" from the Greek words *spondylos*, meaning "vertebra," *rhiza*, meaning "root," and *melos*, meaning "member." The chief characteristics of the disease according to Marie (2) are the coincidence of complete fusion of the spine with more or less pronounced ankylosis of the hips and shoulders, but with relatively slight involvement of the other articulations of the extremities.

It is characterized by an ascending type of ankylosis in which the cervical spine is last and least affected. There is apt to be a greater degree of ankylosis of the hips than of the shoulders, while the sacro-iliac articulations are ankylosed quite early in the course of the disease. There is an excessive forward inclination of the trunk due to flexion-ankylosis of the hips, but the spine itself is more or less straight from the sacrum to the mid-dorsal area; above that point there is a definite forward inclination of the spine, producing kyphosis. The chest and pelvis show a definite flattening in the anteroposterior position, there is respiratory immobility of the thorax, and respiration is almost entirely abdominal.

In order to counteract the forward inclination of the body, these unfortunates stand with the knees flexed and thus maintain their equilibrium, their posture assuming, therefore, the shape of a Z. They are more confortable in bed when lying either on the side or partly upright, with a support under the upper back and the head.

[1] Presented before the Radiological Society of North America at the Eighteenth Annual Meeting, at Atlantic City, Nov. 28–Dec. 1, 1932.

The age of onset is usually in the third and fourth decades, but some cases are seen earlier and some after fifty years of age. The symptoms usually begin as pain in the spine and other joints, with early restriction of motion and final rigidity of the spine, which is bony in character and immobile even under anesthesia. Other symptoms are slight and transitory.

The process consists mostly in calcification of the spinal ligaments, with very little change in the intervertebral discs, which may tend to persist because of the fixation of the vertebræ by the bony wall around them. Most of the spinal ligaments participate in this bony enclosure. Ankylosis of the articular facets, and of the ribs with the vertebræ, is accomplished both by ligamentous calcification and by osseous proliferation. The sacrum is united to the ilia by osseous proliferation so that they become fused as one bone. The vertebræ themselves are not markedly changed. The ankylosis of the hips and shoulders is not due to ligamentous calcification as in the spine, for in these joints there is absorption of the articular cartilage, followed in turn by fibrous and bony union. Marie (2) says that we are dealing more with ossification of periarticular fibrous tissue than a veritable arthropathy.

On the roentgenogram, destruction of the sacro-iliac articulations is one of the first changes noted. Ankylosis is accompanied by irregular calcification in the ligaments of the lumbar spine without corresponding changes in the vertebræ or in the intervertebral discs. As the lesion progresses there is an increase in the amount of calcification in the bony wall around the vertebræ, until they are firmly united. It also gradually extends up the spine until the entire spine is involved. The cervical spine shows the least change, but frequently there is evidence of ankylosis. When lateral views of the spine are made, the intervertebral discs will show little change in thickness. The hips and shoulders do not show much change until the spine is well advanced in the disease process.

The following is an abstract of the essential features taken from Marie's original description of his first case (2). The patient was a farmer, 31 years of age. There was a history of a mild arthritis beginning at the age of 12, with several recrudescences of the disease. The right hip became ankylosed in 1884, which was twelve years before the date of this report. In 1886, the hips and spine became ankylosed, while the cervical spine was the last portion attacked. In 1889 the patient first complained of difficulty in swallowing, and there was gradual progression of the condition until the time of this communication. On Feb. 24, 1896, he presented himself to the author (Pierre Marie) with flexion of both knees. There was also flexion of the pelvis so that the man's trunk and legs presented a Z-shape. The trunk was inclined forward so that it was almost horizontal, the face looking downward at a point three meters from the feet. In order to maintain equilibrium in a standing position, he rested his hands on the anterior portions of the thighs. He had great difficulty in walking with or without crutches, and also difficulty in removing his trousers and shoes as he could not touch his feet with his hands. The hip joints at this time were rigidly ankylosed. In bed, he preferred to rest on the posterior lateral aspect of the trunk, lying on either side with the covers tucked under the parts which did not touch the bed. The thighs were flexed and the feet crossed one over the other. The movements of the upper extremities were restricted only in the shoulders. The excursion of the head in flexion and extension was very limited—it did not exceed 35 degrees—and there were only slight lateral movements. There was marked flattening of the thorax, and the ribs were almost immobile during respiration, which was almost entirely abdominal. If the patient wished to look forward, he raised his head, then flexed his knees, assuming a figure Z. The temporo-mandibular joints were normal; the spine was rigid and presented exag-

geration of the normal curve in the upper dorsal region; there was effacement of the normal curve in the lumbar area, and scoliosis was observed. The muscles were well developed.

This is a rather typical description of various cases that have been reported.

SPONDYLITIS MUSCULARIS—VON BECHTEREW TYPE

This condition was first described by Von Bechterew (3 and 4), who called it "stiffness, with humping of the back." There is a bow-like kyphosis of the cervical and upper dorsal spine, with a compensatory lordosis in the lumbar spine. The spine is sensitive to percussion and is markedly limited in motion. The chest is flat and immobile. The peripheral joints are not affected. It is a slowly progressive disease of unknown etiology, but it appears to bear some relation to trauma and heredity.

Knaggs (1) believes that the most important factor in producing the bow-like kyphosis is the feeble tone of the muscles. He believes that the atrophy of the intervertebral discs is also secondary to the muscular failure and is caused by the increase of pressure at certain points consequent upon the forward bending of the spine.

Von Bechterew studied the nerve root lesions associated with this condition and reports an autopsy on one case. There was evidence of degeneration of the nerve roots in the lower cervical and upper dorsal areas, but there were no changes in the upper cervical area and practically none in the lumbar area. In the areas affected, the posterior roots were almost entirely degenerated throughout, with less marked degeneration of the anterior roots. In the cord, the columns of Goll and Burdach were affected, the area of the latter corresponding to the entry of the posterior roots, and he believed that the degeneration could be explained on the basis of the chronic inflammatory changes in the meninges around the area. There was no involvement of the spinal joints as in arthritis deformans, and no evidence of compression of the nerves due to narrowing of the spinal foramina.

This disease may begin in early life and later become stationary or may develop later in life. It is of the descending type, beginning in the lower cervical and upper dorsal areas, the other joints of the body seldom being affected. The spine becomes entirely rigid, due to fusion of the bodies of the vertebræ anteriorly; the intervertebral discs become narrowed or entirely disappear and when this happens, the vertebral bodies approximate and fuse anteriorly by a layer of bone. There is, however, no calcification of the ligaments as is seen in the Marie-Strümpell type of arthritis. There is conspicuous deformity, due to the rounded kyphosis in the upper dorsal and lower cervical areas causing the upper trunk and head to be projected forward to a noticeable degree.

The roentgenogram shows a rounded kyphosis of the upper dorsal spine, with narrowing of the discs and various changes in the vertebræ, ranging from slight bone production to complete bony fusion anteriorly. There is also a noticeable lack of extensive changes in the lower spine.

SPONDYLITIS SENILIS

Knaggs (1) and Steindler (5) believe the changes noted in the spine in old age may be regarded as a variation of spondylitis muscularis. In senile kyphosis we find narrowing of the discs, with fusion of the vertebræ which may also show narrowing. The normal curves of the spine are absent and there is apt to be a generalized arcuate kyphosis, with forward inclination of the head and upper trunk. In this condition the narrowing and disappearance of the discs are not limited to the upper dorsal area, but may extend throughout the spine. Knaggs (1) states that weakness and atrophy of the muscles progress simultaneously with shrinkage and disappearance of the intervertebral substances. He believes that

the weakened muscular power tends to aggravate the deformity.

SPONDYLITIS OSTEOARTHRITICA—HYPERTROPHIC ARTHRITIS

Hypertrophic arthritis of the spine is more apt to develop after fifty years of age and is most frequent in males. It is found many times in individuals who have been engaged in occupations requiring arduous labor and some authors feel that this has a definite etiologic bearing.

It is usually a generalized condition and is frequently associated with involvement of peripheral joints. The changes in the spine are similar to those in other joints in that there are marginal osteophytes with eburnation, and narrowing of the joint spaces in late cases. The eburnation is often not as marked, however, as it is in the peripheral joints, which appears to be due to the limited motion of the spinal joints as compared to other joints. Pain and restriction of motion are the common symptoms in early cases, with a dorso-lumbar convexity of the back in the late cases after absorption of the discs.

Baetjer and Waters (6) state that the first x-ray change to be noted will be a flattening of the edge of the vertebra where the lateral ligaments are attached. Exostoses form later at these points and slowly extend toward the adjacent vertebræ. These may develop until they form a bony bridge between the vertebræ. However, bony ankylosis of the vertebræ in hypertrophic arthritis is not the rule. In many advanced cases large hook-like spurs will be seen that appear to impinge but do not unite. Knaggs (1) says that a study of proven cases among museum specimens showed that fusion of the articular surfaces of the bodies and of the articular processes was unusual, that ankylosis of the ribs to the vertebræ had not occurred, and that the laminæ and spinous processes were not united by bone. He believes that in instances in which fusion did occur, "it was in circumstances where pressure and probably complete immobility were possibly determining factors."

RELATION OF PARATHYROIDS TO ANKYLOSING SPONDYLITIS

Oppel (7) believes that spondylitis rhizomelique and spondylitis muscularis are stages of the same disease and that the difference is quantitative rather than qualitative. He prefers the name "ankylosing polyarthritis" to cover both conditions.

In studying a group of these cases, Oppel found a definite hypercalcemia and a decrease in the electro-excitation of the muscles. Since the hormone of the parathyroid bodies had been shown by Collip to increase the level of the blood calcium, Oppel concluded that hyperparathyroidism and ankylosing spondylitis were related. He proposed the theory that the arthritic syndrome developed after certain infections, in persons possessing a predisposition or constitutional tendency to hyperparathyroidism.

He quotes Samarin's study in 49 cases to the effect that, following parathyroidectomy, there was improvement in 33 cases and no improvement in the other 16. Oppel says that obviously the permanent changes cannot be cured but that the disappearance of hypercalcemia stops the process of progressive ankylosis and that this is the most important result of the removal of the parathyroid glands. He believes also that the reduction of the hypercalcemia in some way influences beneficially the function of the voluntary muscles, giving them greater freedom of movement.

LeRiche and Jung (8) also believe that in cases of polyarthritis associated with hypercalcemia, the removal of the parathyroids has much to offer and should be done early. Ballin and Morse (9) likewise include multiple ankylosing arthritis in the chapter on parathyroidism.

DISCUSSION

It would be logical to attempt to classify the chronic arthritides of the spine under the broad headings—atrophic and hypertrophic—as are used in generalized arthritis. It is difficult to obtain an agreement on this, as the findings in the spine vary considerably from those in the peripheral joints. It is suggested by some authors that this may be due to the relative immobility of the spinal joints as compared to the peripheral ones. There are, in all probability, other factors such as abnormal pressure on the vertebral bodies due to lack of muscle tone or arduous labor, which would seem to play some part.

Spondylitis rhizomelique is usually classified under the head of atrophic arthritis. The changes in the spine itself vary from the peripheral type in that there is usually no narrowing of the joint spaces and no bone destruction and no bone proliferation, but rather a calcification of the periarticular structures. The etiology is usually ascribed to toxins from infectious processes as in atrophic arthritis. Hypertrophic arthritis is, of course, similar to hypertrophic arthritis elsewhere, with narrowing of the joint spaces and with varying degrees of marginal osteophytes, without ankylosis as a rule.

Great care must be taken in the evaluation of the changes shown by the roentgen film, owing to the osteophytic changes that may be present from static and mechanical stresses, and from senility. These help to explain the relatively extensive hypertrophic changes which are frequently found in the spine without a corresponding degree of symptoms. Spondylitis muscularis, or the Von Bechterew type, and the so-called senile kyphosis are placed in the hypertrophic group by Steindler (5), who believes that faulty posture, occupational strain, etc., may predispose to this condition. Knaggs, as noted above, is of the opinion that feeble tone of the muscles, with a consequent increase of pressure on the vertebræ by forward bending of the spine, is the most important etiologic factor. Heredity is also said to be a factor and various members of a family may be affected.

Spondylitis rhizomelique usually begins in the third and fourth decades or even earlier. Spondylitis muscularis may also begin in early life, and later become stationary, or may develop later in life. Hypertrophic arthritis usually begins after fifty, but may show some changes earlier.

The ankylosis of the spine produced by these arthritides is another point of classification by certain authors. They place spondylitis rhizomelique and spondylitis muscularis in one classification and designate them by the term "chronic ankylosing polyarthritis," or "spondylitis ankylopoietica." Spondylitis rhizomelique is an ascending ankylosis, beginning in the sacro-iliac joints and progressing up the spine until the entire spine is held rigidly by calcification of the ligaments surrounding it. Spondylitis muscularis is of the descending type, beginning in the upper dorsal and lower cervical spine and often not involving the lower lumbar area. In this, the vertebræ are approximated by absorption of the discs and the vertebræ are united anteriorly by a bridge of bone. Hypertrophic arthritis, on the other hand, produces huge osteophytic spurs around the vertebral margins, but usually does not produce ankylosis. Oppel (7) not only designates spondylitis rhizomelique and spondylitis muscularis as stages of the same disease, but believes the etiology to be hypercalcemia induced by hyperparathyroidism. He recommends removal of the parathyroids in the treatment of this condition. He does not claim a disappearance of the existing arthritis but states that as the hypercalcemia is eliminated, the progressive ankylosis stops. He also believes that there is a greater freedom of movement of the voluntary muscles. These observations have been confirmed by several other authors. We believe that many more observations over a longer period of time are necessary before this theory can be fully accepted.

When the characteristics of spondylitis rhizomelique and spondylitis muscularis are compared, it seems rather odd that they should be considered as stages of the same process. The pathology of the two conditions is quite different; the signs and symptoms and development of the two diseases are also radically different; the etiology, as given by most authors, is also distinct—the main points of similarity are ankylosis of the spine, with kyphosis in the upper portion.

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CANCER OF THE PROSTATE

THE RESULTS OF RADIUM AND ROENTGEN-RAY TREATMENT[1]

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THE purpose of this paper is to evaluate the results of roentgen-ray and radium treatment for 152 cases of cancer of the prostate in the Radiological Department of the Philadelphia General Hospital. Since nearly every case required admission to the hospital when first seen, the study obviously resolves itself into an analysis of the palliative benefits of radiation for clinically advanced cases. The question is often raised: How much value is high voltage radiation for the late and advanced cases? Is it really worth while?

With this object in view it seemed necessary: (*a*) to associate the relevant clinical data of age, duration of symptoms, diagnosis, extent of involvement, bone and gland metastasis as well as pathologic characters, and (*b*) to outline and discuss the technical procedures of radiation employed.

For the study of the irradiation group, 82 cases were selected because they were known to have received an adequate dose of high voltage roentgen rays as compared with a clinically similar group of 70 cases receiving no irradiation. Every patient in this series died. The terminal stages of the disease in each instance were typical of cancer.

The clinical factors were so variable that it was obviously difficult to evaluate end-results on the basis of statistics. Moreover, the beneficial effects are not always in conformity with statistical estimations, neither is the palpable extent of involvement a true record of the actual extent of the disease. The time incidence of the first symptom on hospital records does not always indicate the onset of the disease by any means.

In many instances roentgen-ray studies are negative for bone metastasis, yet it is possible for metastasis to exist and to be of such slight involvement that it is not readily subject to x-ray demonstration. There were several instances in this series in which cases presented lumbar and sacro-iliac pains of sufficient intensity to justify the inference of metastasis, yet this evidence was not obtained to a definite and indisputable degree for as long as from two to four months in five cases in this group.

The advanced stages of the material in these 152 cases is indicated by the fact that 82 per cent were admitted to the hospital when first seen, only 18 per cent being at first treated as ambulatory cases. On the other hand, the cases with high or medium degrees of malignancy are probably representative of the average case from the standpoint of duration of symptoms when medical advice is first obtained, because the average duration of symptoms at the first consultation was from six to twelve months. The only cases in this series that are probably not representative of what might be regarded as clinically "early," are the group of so-called low grade malignancies.

In this series there were 101 out of 152 patients who recognized symptoms within 12 months, grouped as follows: 57 within 6 months; 42 within 12 months; 27 with definite symptoms persisting over a period of two years; 6 for 3 years; 7 for 4 years; 8 for 5 years, and 5 had symptoms longer than 5 years. These latter two groups were obviously low grade malignancies and the life cycle from admission to death was brief because of a rapidly failing health and strength on admission, compatible with the terminal stages. These observations on the duration of

[1] Read at the Eighteenth Annual Meeting of the Radiological Society of North America, at Atlantic City, Nov. 28–Dec. 1, 1932.

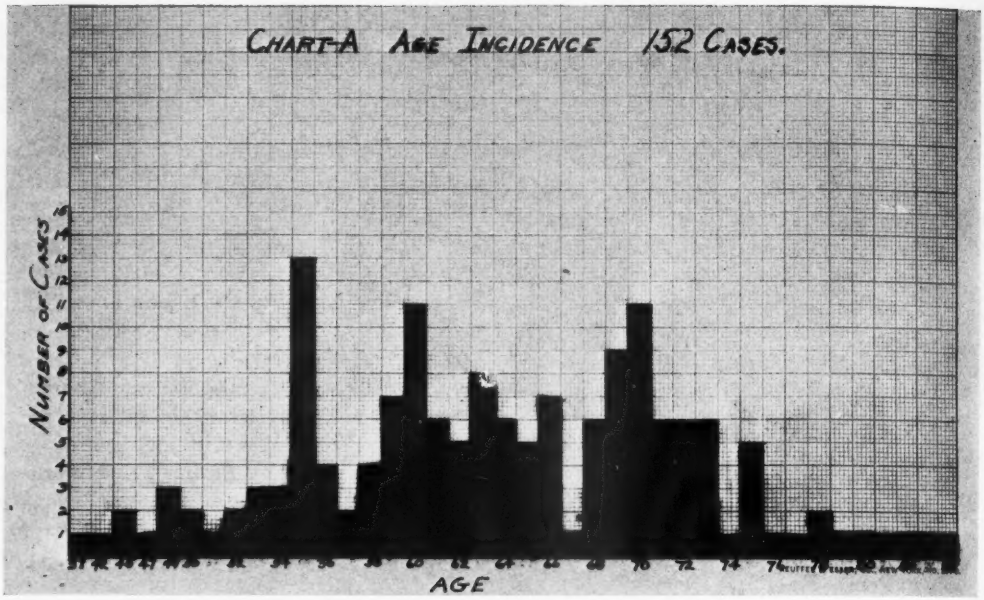

Chart A. Age incidence, based on 152 cases.

symptoms from the first recognition by the patient until admission to the hospital are important because they show that 128 (84 per cent) of the cases presented symptoms over a period of less than two years. This evidence points to a preponderance of material coming within the range of the higher grade types of malignancy. The relatively short life—from the time of admission which was the time of beginning irradiation, and discussed in more detail later—substantiates this inference of clinically high grade malignant cases.

The age incidence is not significant. As shown by Chart A, the preponderance of cases occurred between 55 and 75 years. The correlation of age with the extent of residual urine, duration of symptoms, extent of involvement, and the cellular differentiation is an especially important prognostic criterion, and the facts brought out by it will be dealt with in more detail later.

Frequency, difficulty in urination, painful urination, and nocturia were the outstanding symptoms. It is significant to note the frequency of the symptom of weakness and especially loss of weight (Table I). "Backache" was so prominent and varied in its distribution that it should always be regarded with suspicion after middle life. Pain constituted a major complaint in nearly 70 per cent of these cases.

The symptom of obstruction was frequently described as "difficulty on urination," and records are not entirely satisfactory on this score.

Bone metastasis occurred in 38.5 per cent of 152 cases. The incidence of bone metastasis in other reports has been about 30 per cent—Bumpus (1), Ferguson (2), Smith and Pierson (3). Chaulk and Boonitt, (4) state it to be 18 per cent in their cases.

The most frequent site of bone metastasis was in the pelvis (Table II), a region which was affected in 51 out of 60 cases. Lumbar spine involvement was next in frequency; the chest was involved in nine cases, and the skull in six. In none of these patients was metastasis found below the

elbow or knee joints. Pathologic fractures were noted in only four cases.

TABLE I.—INCIDENCE OF FIRST SYMPTOMS AS NOTED BY THE PATIENT

Frequency	80	Cases
Difficulty in urination	76	"
Painful urination	71	"
Nocturia	69	"
Weakness	61	"
Pain in back, hips, and knees	59	"
Obstruction	47	"
Loss of weight	43	"
Hematuria	42	"
Burning	37	"
Lumbar pain	33	"
Sacro-iliac pain	30	"
Polyuria	28	"
Incontinence	20	"

TABLE II.—INCIDENCE OF BONE METASTASIS

Pelvis	51	Cases
Lumbar spine	38	"
Femora	18	"
Dorsal spine	16	"
Ribs	14	"
Humeri	10	"
Chest	9	"
Skull	6	"

TABLE III.—RECTAL EXAMINATION OF THE PROSTATE

Enlarged	99	Cases
Hard	96	"
Nodular	43	"
Painful	23	"
Irregular	21	"
Clinically normal	21	"

The Wassermann test was positive in only 12 cases, an incidence within the average range of 10 per cent positives for males. Enlarged inguinal nodes were detected in four cases, an interesting observation which conforms with the relative infrequency of inguinal node metastasis in cancers of the female pelvis (excepting vulva), and is supported by the studies of Chaulk and Boon-itt (4) and Dossott (5). Edema of the extremities was present on admission in 14 cases—in nine of them the edema was marked, and existed in three of those cases referred from other hospitals following partial prostatectomy.

There had been surgical intervention in 11 cases before admission, as follows: recurrence following prostatectomy, five cases; cystostomy, four cases, and punch operation, two cases.

In every instance the clinical diagnosis was obvious on the basis of rectal findings of enlarged, hard, nodular, and infiltrating characters of the prostate gland. The size in each instance was in excess of 5 cm. diameter. In 21 cases the prostate was normal as far as could be determined by a clinical examination; the diagnosis was made accidentally following roentgenographic studies for "backache" in 18 cases. Operation for obstructive symptoms in three clinically normal cases revealed carcinoma.

It is well known that minute growths of the prostate escape detection (Chaulk and Boon-itt, 4; Hirsch and Schmidt, 6). A negative report on tissue cannot eliminate carcinoma unless the entire gland has been carefully sectioned. Three cases in this series had prostatectomy elsewhere for a clinically hypertrophied prostate: in two cases carcinoma was not recognized; in one case a small pea-sized nodule was found on careful sectioning and reported malignant. All three of these cases had extensive local recurrence on admission within one year after the operation.

Ferguson (2) reviewed the literature of 1,426 cases in which the prostate was removed with the clinical diagnosis of benign enlargement, and in which 183 early or borderline cancers were found. Not one of these cases showed the posterior lobe involved but, rather, the lateral or median lobes.

Cunningham (7) found carcinoma of the prostate in 20 per cent of the obstructive prostatic cases. Of 700 cases with obstructive symptoms, Barney and Gilbert (8) found that 23.9 per cent of their prostatic cases were due to malignancy. Davis (9) found 250 cases of cancer of the prostate occurring in 2,000 instances of prostatic obstruction observed at Johns Hopkins Hospital. This experience led him to conclude that cancer of the prostate should be suspected in the presence of extensive induration, fine nodules, or induration and obliteration of the median notch of the bladder base.

Benign hypertrophy does not exclude

the possibility of carcinoma. Microscopic studies were made in 40 cases—11 suprapubic operations, and 29 autopsies. An attempt was made to evaluate the end-results of irradiation or no treatment, according to the clinical course of the disease, age of patient, duration of symptoms, extent of involvement, residual urine, and cellular differentiation of the growth according to the observations of Ferguson (2). He describes three clinical types of carcinoma characterized by such a clinical syndrome and certain pathologic features which he found to be indicative criteria for establishing a prognosis. The cases were accordingly classified as high, intermediate, or low malignancies, with an average life of 6 months, 18 months, and from 30 months to many years, respectively. The age incidence was 55, 60, and over 65 years for the high, medium, and low malignancies, respectively.

Dr. Custer, of the Pathological Department of the Philadelphia General Hospital, is at present making an exhaustive analysis of this group of cases which he will report in detail at a later date. His preliminary findings seem to support the clinical index factors of malignancy observed by Ferguson.

There is ample evidence to indicate that the clinical diagnosis for early cases is difficult. When this diagnosis is suspicious from the standpoint of symptoms, and a rectal examination demonstrates enlarged, hard, and nodular infiltrations, then the case is probably advanced and well out of range of operability. Obstructive symptoms may occur in carcinomas of the prostate, but may also be the result of simple hypertrophy. Many early lesions of the prostate have been discovered accidentally following prostatectomies for clinically benign hypertrophies.

High voltage radiation has been of tremendous benefit not only from the standpoint of relief of pain, but for relieving obstructive symptoms. Smith and Pierson (3) do not believe that radiation is beneficial in relieving obstruction. Barringer is of the opinion that at least from 5 to 10 per cent of prostatic tumors are highly cellular and undifferentiated types of cancer, and, therefore, most malignant and most sensitive to radiation.

It is difficult to estimate the effects of roentgen rays on the size of the growth. In the majority of these cases the growth ranges from 5 to 7 cm. in diameter and in a few instances even larger. There is generally infiltration about the seminal vesicles, and almost always symptoms associated with a cystitis and sometimes a pyelonephritis. The question of supportive operative procedures such as punch and cystostomy or retention catheters must always be considered. It is difficult to evaluate these methods because each case is an individual problem and must be analyzed from the standpoint of operability.

Barringer (10) believes that it is possible to control from 10 to 15 per cent of cancers of the prostate for three years or more by irradiation methods. In many cases in which the disease is confined to the posterior region of the prostate, between the fascial planes, and without involvement of the bladder neck, the use of radon needles implanted through the perineum is advised. In cases in which the tumor involves the bladder neck, cystotomy and implantation of gold radon seeds into the prostatic tumor are to be preferred.

Davis (9) believes that a limited number of cancers of the prostate are suitable for radical prostatectomy. Many more cases benefit by the implantation of gold radon seeds in the tumor after either perineal or suprapubic exposure.

Geraghty (11) believes that surgery alone is hopeless in 95 per cent of the cases of carcinoma of the prostate. The combination of surgery and radium seems to offer the best results according to Bumpus (1), Chute (12), Barney and Gilbert (8). Chaulk and Boon-itt (4) advocate the punch operation to relieve obstructive symptoms, and combine this procedure with radium or roentgen rays or both to effect growth restraint. Smith and Pierson (3) recommend roentgen-ray treat-

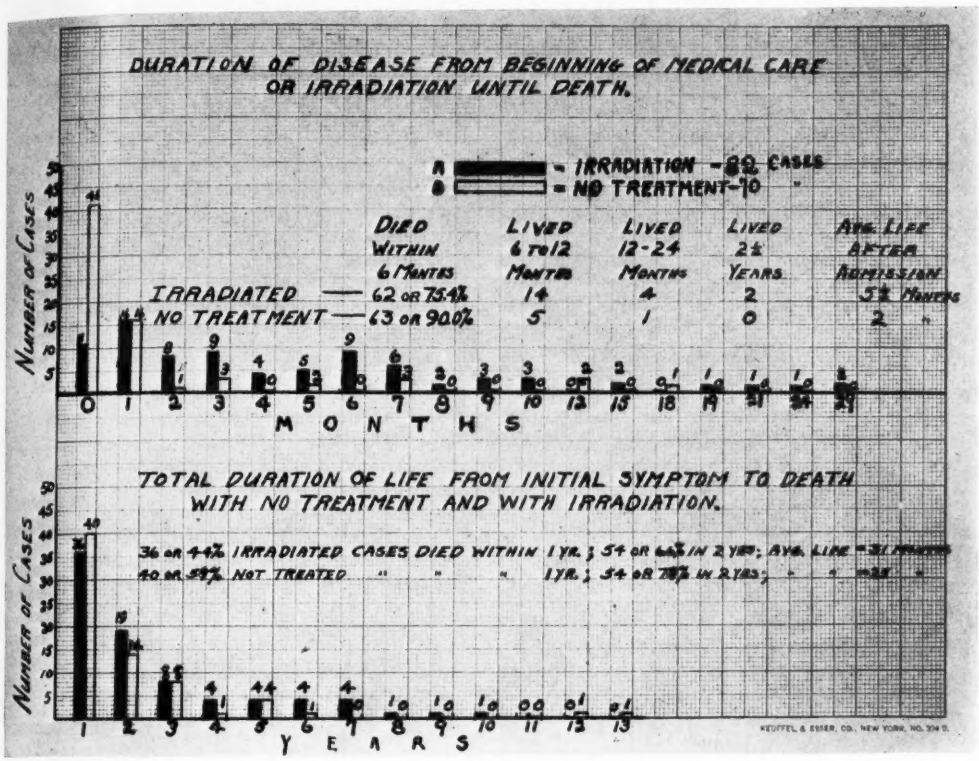
DURATION OF DISEASE FROM BEGINNING OF MEDICAL CARE OR IRRADIATION UNTIL DEATH.
A = IRRADIATION - 82 CASES
B = NO TREATMENT - 70 "
Died Within 6 Months
Lived 6 to 12 Months
Lived 12-24 Months
Lived 2+ Years
Ave. Life After Admission
IRRADIATED — 62 OR 75.4% 14 4 2 5½ Months
NO TREATMENT — 63 OR 90.0% 5 1 0 2 "
NUMBER OF CASES
MONTHS
TOTAL DURATION OF LIFE FROM INITIAL SYMPTOM TO DEATH WITH NO TREATMENT AND WITH IRRADIATION.
36 OR 44% IRRADIATED CASES DIED WITHIN 1 YR.; 54 OR 66% IN 2 YRS;
40 OR 57% NOT TREATED " " " 1 YR.; 54 OR 78% IN 2 YRS;
NUMBER OF CASES
YEARS

Chart B.

ment for cases not suitable for surgery. Attwater (13) discusses at length the relative merits of surgery and radiation and favors radiation.

Roffo and Astraldi (14), after an extensive review of the literature on the effects of radium, roentgen rays, and surgery for cancer of the prostate and on the basis of their own experience also, conclude that the results have been most unsatisfactory, and that the only treatment is palliative cystotomy. Astraldi (15), reporting the service of Professor Lequen, of Paris, prefers not to interfere surgically, believing that the patient will have a longer life if left undisturbed. He has discarded roentgen rays and radium.

Pain, frequently relieved when roentgenographic evidence of metastasis has been proven, may be due to perivascular or perineural metastatic infiltrations, the pressure of enlarged infiltrating prostatic neoplasms or enlarged nodes, and cystitis or pyelonephritis. In radiosensitive lesions the relief of pain is sometines phenomenal. In many instances, growth restraint is obtained by way of increased fibrous tissue formation, especially if the treatment can be carried out over an intermittent period of from six to twelve months.

The life cycle evaluation is not of much value without an analysis of each case record. The disease probably exists in many cases for a long time before any definite symptoms are recognized by the patient. Radiation treatment is of no special value for metastatic bone disease except from the standpoint of relief of pain. It does not retard progressive bone changes.

The factor which indicates beneficial effects of radiation is chiefly relief of pain. Diminutions in the extent of the primary growth and relief of obstructive symptoms

have also been noted in many instances. The general health and duration of life are not especially valuable criteria for estimating beneficial effects of radiation, because these conditions may be affected by a carcinoma which existed long before symptoms developed, or complications of a cystitis or pyelonephritis, as well as unrecognizable metastasis.

The duration of life after admission to the hospital was five and a half months for 82 irradiated cases, as compared with two months for 70 cases receiving no treatment (Chart B). Of the irradiated cases, 75 per cent died within six months after beginning treatment, as compared with 90 per cent receiving no treatment. Four cases lived from 12 to 24 months and two cases lived 29 months with irradiation. Only one case lived beyond a year (18 months) without treatment after admission. The average total life for the irradiated group of 82 cases was 31 months, as compared with the average total life of 25 months in the group of 70 cases receiving no treatment. There was 34 per cent of the irradiated cases alive at the end of two years, as compared with 25 per cent of those receiving no treatment.

Chaulk and Boon-itt (4) found an average life of from 25 to 38 months with combinations of radium, roentgen rays, and punch operation, as compared with radium or roentgen rays alone combined with punch operation.

Bumpus (1) found that 31 per cent of the cases treated surgically survived two years, as compared with a group of radium-treated cases which showed only 17 per cent surviving for two years. Of the cases receiving no treatment, 92 per cent died in two years. The average post-operative life reported by Bumpus was 27 months, as compared to 28 months for the radium-treated cases.

The technic of high voltage roentgen-ray treatment was as follows: 200 K.V.; 30 ma.; 0.5 mm. Cu plus 2 mm. Al; 50 cm. distance; field 15 × 20 sq. cm.; cross-fire, 4 fields over pelvis; so-called mechanical rectification. The dose with these factors is 800 r units. The treatment was carried out along the lines of saturation (Pfahler), and the four fields as recommended by Weatherwax and the writer. At the end of about two weeks a total dose of approximately 200 per cent E.S.D. was attained in the tumor-bearing area, according to depth dose chart estimations. At the end of six weeks, if the physical condition of the patient permitted, another such series of treatments was given. Of 82 cases treated, 34 received one series of treatments; 29, two series of treatments; 15, three series of treatments, and 4 were given four series of treatments. In 19 cases, the first series of treatments was supplemented with heavily filtered radium packs to the anterior and posterior pelvis. This additional radium treatment amounted to approximately 125 per cent additional radiation to the skin. In 17 cases, rectal tampons were used with an estimated dose ranging from 0.5 to 3 E.S.D. The filtration for the rectal tampons was 0.5 mm. silver and 3 mm. lead, which is equivalent to the density of 2 mm. of platinum. There was no evidence to indicate that the rectal tampon treatment offered any special benefit except in a few instances in which the growth was apparently highly cellular in character and the relief of obstructive symptoms was marked.

In eight instances gold seed implantations were used, but the marked clinical extent of local involvement was such that the results were not satisfactory. This experience was sufficient to set up a new working basis for interstitial radiation, which will be confined in the future to cases with clinical involvement well within the confines of surgical operability.

CONCLUSIONS

It is difficult to evaluate irradiation for advanced cancer of the prostate on the basis of the total longevity cycle or even the total duration of life from the beginning of treatment for the following reasons: (1) disease may have existed for an in-

determinate period of time before the recognition of the first symptom; (2) the degree of local involvement and the extent and duration of metastasis cannot always be estimated accurately; (3) averages of a large group of a 1,000 or more cases are necessary to set up substantial criteria for such estimations; (4) unless microscopic studies with special reference to the cellular differentiation are carried out in each case, the variable responses to irradiation cannot be properly evaluated.

This series of 152 cases represents an extremely advanced type of case: bone metastasis was found in 40 per cent; hospital care was necessary in 82 per cent when first seen.

A correlation of the clinical data with cellular characters in 40 of the cases supports the findings of Ferguson (2) of a decided relationship to the longevity cycle and the prognosis—the more highly cellular, the more highly malignant, and, conversely, the more highly radiosensitive.

Enlarged, hard, infiltrating, and nodular prostates are almost always certain evidence of malignancy. Local involvement of this extent generally indicates inoperability. The success of surgery in many reported cases of clinical cures seems to have resulted from accidental findings of malignancy following prostatectomies for simple hypertrophies.

There is not sufficient material in this report to evaluate gold seed implantations. Supplementary heavily filtered radium tampons have been beneficial in the highly cellular growths, but the total dose should never be in excess of one erythema dose because of the distress resulting from rectal irritation. High voltage roentgen rays in 82 cases of this series have been of tremendous benefit in relieving pain and diminishing obstructive symptoms. These results have been so striking in a large number of cases that the recommendation of high voltage irradiation procedures for advanced cancer of the prostate is justified in every case in which the physical condition of the patient is sufficiently good to tolerate intensive treatment. There is some evidence in this series of cases to indicate an increased duration of life from irradiation. In selected early cases this result may be expected to be great.

SUMMARY

Beneficial effects for the most part must be determined on a basis of immediate clinical results.

The early diagnosis is difficult. The aspiration method holds out great possibilities in this respect.

Cancer of the prostate is essentially a radiologic problem. In selected early cases, interstitial radiation with gold seeds or platinum needles should offer great possibilities of improving the end-result.

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NEW METHOD FOR VISUALIZATION OF THE UNOBSTRUCTED ESOPHAGUS[1]

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IT has always been quite simple, with the aid of a thick barium mixture, to obtain satisfactory radiographs of the obstructed, or partially obstructed, esophagus, but the normal or unobstructed esophagus has presented a more difficult problem. In view of these difficulties, various devices have been instituted such as having the patient swallow the barium mixture while in the horizontal position or the more elaborate procedure of introducing a fish skin filled with barium into the esophagus. All of these methods having been productive of more or less indifferent and uncertain results, it occurred to us that there might be some procedure by which at least a partial voluntary control of the so-called "cardiac sphincter" could be brought about. With these thoughts in mind we set about accomplishing this result, with what, we feel, is a gratifying degree of success.

From long experience in esophagoscopic examinations, one of us (E. B. F.) was forcibly impressed by the fact that, in almost every instance, while viewing the cardiac opening through the esophagoscope, it was seen to open and close rhythmically, synchronous with respiratory action. With this fact in mind, we set about making extensive fluoroscopic studies of the swallowing act, using a rather thick barium mixture. The subjects upon which these studies were made were persons who had never had the slightest suggestion of dysphagia or even a history of temporary cardiospasm.

Of course, it is axiomatic that respirations must be suspended in order to accomplish the deglutitory act; also, it must be understood that all of these studies were made with the patient in the erect position. The results revealed some very interesting facts which may be briefly stated.

1. Barium swallowed at the end of a full forced inspiration passes at a leisurely rate through the cardia into the stomach.

2. Barium swallowed when respiration is suspended in the midst of a normal inspiration or expiration passes very rapidly through the esophagus and cardia in a thin stream, the organ itself being in a more or less collapsed condition.

3. Barium swallowed when respiration is momentarily suspended at the end of a forced expiration is held in the esophagus for several seconds and causes a rather remarkable dilatation of the organ, which, in some cases, is almost as marked as is seen in early cardiospasm.

Of course, if too much fluid is swallowed, even following forced expiration, the temporary sphincteric action is overcome by sheer weight and volume and the whole mass rushes precipitously into the stomach. We have usually found that two or three moderate swallows of fluid were sufficient to produce the desired result and yet not enough to overcome the sphincteric action.

Procedure.—Having completed our fluoroscopic studies, we proceeded to attempt to obtain satisfactory radiographs of the normal esophagus. The subjects were placed standing in the right anterior position against the upright cassette and instructed to take two or three deep breaths. At the end of a forced expiration they were told to swallow two or three mouthfuls of a rather thick barium mixture and as soon as this had been accomplished, the exposures were made. This procedure was rehearsed two or three times in order that there might be no misunderstanding and to make sure of satisfactory results. By this method we were able in

[1] Presented before the Radiological Society of North America at the Eighteenth Annual Meeting, at Atlantic City, Nov. 28–Dec. 1, 1932.

the majority of cases to obtain satisfactory outlines of the filled esophagus. A barium mixture which is definitely thicker than that used in the ordinary gastric series is recommended and, it goes without repeating, careful rehearsing and instruction of the patient are essential to good results. We believe that if these methods are followed carefully, any roentgenologist can produce good radiographs of the normal filled esophagus without much practice and with no added expense.

It might be well to pause at this point to offer some conjectures as to the cause of the phenomena noted. At the present time, the best that one can do is offer conjectures, because it is universally accepted that up to the present time very little is really known concerning the innervation, structure, and function of the tissues forming the cardiac opening. Rake and others have made exhaustive microscopic studies of tissue removed at autopsy from the lower end of the esophagus of a few patients suffering from so-called "chronic cardiospasm," but such exhaustive studies have not, to our knowledge, been carried out in individuals having a normal esophagus and dying from other causes.

In one specific case of chronic cardiospasm, Rake made something over two hundred serial section studies embracing not only the region of the cardia, but also the adjoining segments above and below. In these sections, he states specifically, definite degenerative changes were seen in Auerbach's plexus in and near the cardia, but in the adjacent portions above and below, an almost normal appearance of the plexus was noted.

In the same article, Rake states, in reference to the work of Berkell, "He has shown that the ganglion cells of Auerbach's plexus are all cell stations on the vagus." Langley, Kronecker, and Meltzer substantiate Rake's views and conclude that "the production of achalasia (lack of normal relaxation) of the cardia must depend on a lesion of the vagus nerves somewhere in their course." Other observers have been unable to demonstrate these changes in Auerbach's plexus in cases of so-called chronic cardiospasm. In fact, one of us (E. B. F.) has recently reported a case of extreme cardiospasm which came to autopsy, in which, according to Dr. Clarence L. Cohn, of Dr. Bloodgood's laboratory, no degenerative changes in Auerbach's plexus were demonstrable.

As to the matter of sympathetic nerve supply, Gaskell states that the esophagus receives no sympathetic nerve supply. Other observers have stated to the contrary—that the esophagus receives sympathetic fibers throughout its whole course. Rake says that "the truth lies between the two extremes. The extent of the sympathetic supply has never been accurately determined, but it seems probable that at least the whole of the sphincter receives a dual nerve supply." It is quite evident, therefore, that the matter of nerve supply of the so-called cardiac sphincter is still very much unsettled and is still a highly controversial subject.

As to the musculature surrounding the cardiac opening, there is almost an equal amount of controversy, to the extent that some observers have denied the very existence of a cardiac sphincter. Jackson has suggested that the crura of the diaphragm may be the sole structures furnishing the sphincteric effect at this point, whereas, on the other hand, Baillei, in 1807, described a true anatomical sphincter. In all fairness to both views, Rake concludes, from radiologic studies, that, regardless of whether or not a true anatomical sphincter exists, "the last inch, or more, of the esophagus has such a totally different function from that of the rest, that it deserves to be regarded as a functional sphincter."

As far as the function of the lower inch or more of the esophagus is concerned, it has been quite definitely observed both by ausculatory and fluoroscopic means, that a single swallow of fluid hesitates normally at the cardia at least six or eight seconds, before entering the stomach. We do not know the exact reason why this should be true. We are personally

convinced, however, that, aside from the nervous and muscular control of the cardiac opening, certain mechanical factors incident to normal respiratory movements have varying effects upon the deglutitory function, either through the effect of the movements of the diaphragm or through the production of definite intrathoracic pressure changes. The more so because, while experimenting with a balloon in the cardia of dogs, we have noted a remarkable dilatation of the cardia resulting from stimulation of the phrenic nerves and consequent strong contractions of the diaphragm. The pressure factor, of course, was entirely eliminated in this instance because the thorax had been opened in order to stimulate the phrenics artificially.

We are also convinced that certain anatomical features consequent to the bodily form of the subject and causing a variation of the course of the esophagus, particularly in the lower third, have a direct bearing upon the above-mentioned mechanical features. In the case of long-chested individuals with a narrow costal arch, we have seldom failed to get a satisfactory outline of the esophagus on the very first attempt. On the other hand, we have had considerable difficulty and not a few failures in individuals with a short chest and wide costal angle.

In this connection we have found that there are a certain small number of individuals who retain the barium in the esophagus much better at the end of a full inspiration than at the end of a forced expiration. It is inconceivable that these individuals should be possessed of a diametrically opposite innervation from that usually possessed by the average normal person, and, in consequence, we have been forced to attribute this result to some mechanical factor. In fact, this reaction is characteristic of all the cardiospasm cases which we have studied, *i.e.*, the esophagus retains the barium much better at the end of a full inspiration than it does after forced expiration. In fact, it is possible that these individuals may be classified as potential cardiospasm cases, or, if Rake be correct in his assertion, that the condition is not one of true spasm but, rather, a lack of normal relaxation of the cardia. It seems plausible that varying degrees of this normal relaxation may be found even in cases not suffering to any appreciable extent with symptomatic esophageal disease.

At any rate, we feel that we have been able, through this procedure, to outline a great many cases of normal esophagus and, with continued effort, we hope to be able to throw more light, not only upon the normal function of deglutition, but also as time goes on, to contribute something of value to the knowledge of that very interesting condition known as "chronic cardiospasm."

SOME NEW PRINCIPLES IN THE DESIGN OF X-RAY APPARATUS[1]

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FIVE years ago the writer had the privilege of reading a paper in this city before the Radiological Society of North America on the subject of "Self-protecting Tubes and Their Influence on the Development of X-ray Technic."[2] Some of the principles already mentioned in that paper led to the design of fully protected, shock-proof x-ray tubes and apparatus, both for diagnosis and therapy. It is with great pleasure that to-day he finds opportunity to report on a few of the newer principles worked out by this laboratory. Some of these new features have been published in European periodicals only recently; the others, however, have not hitherto been published anywhere.

A. Reduction of exposure time for x-ray tubes with stationary anode by a new method of loading.—The maximum temperature of the anode surface is normally reached only at the end of the exposure time. The temperature rises, as is indicated in the drawn line of Figure 1-*A*. A larger load would be permissible at the beginning of the exposure, as the temperature of the anode is then far below its admissible limit. The increase of load may be such that the temperature limit is reached practically at once and then maintained during the whole exposure time. With such an increased load it is obvious that an exposure may be made in a shorter time than would be possible with a normal load.

Figure 1-*B* represents in the drawn line the exposure of constant load, the dotted line represents the initially increased and then decreased load, the total exposure being the same in both cases.

Calculation and experiment show that a reduction of exposure time of about 40 per cent is possible with this new method. Figure 2-*A* shows the results of the calculation of temperatures in and behind the anode surface for different exposure times for constant load.

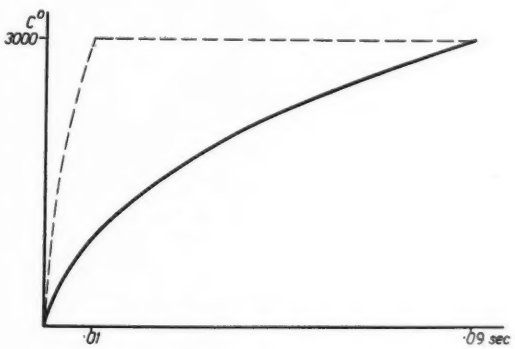

Fig. 1-*A*. Rise of temperature during a normal load (continuous curve) and during a falling load (dotted curve).

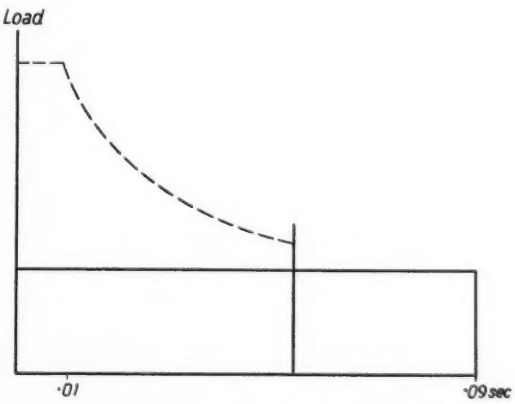

Fig. 1-*B*. Represents the two loads. The total power is approximately equal in each case.

Figure 2-*B* shows the temperature curves for decreasing load, the maximum temperature of 3,000° being maintained from the

[1] Read before the American Congress of Radiology, at Chicago, Sept. 25–30, 1933.

[2] RADIOLOGY, September, 1929, XIII, 191.

beginning. A more complete description has been recently published.[3]

The decreased load with constant voltage is obtained by automatically altering the filament resistance of the tube after a very short time. The electron emission of the filament decreases with the decrease of temperature of the filament.

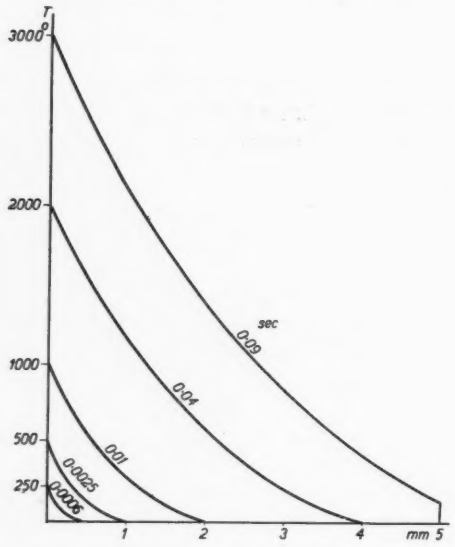

Fig. 2-*A*. Distribution of temperature in the anode during normal load. Gradient at the surface constant.

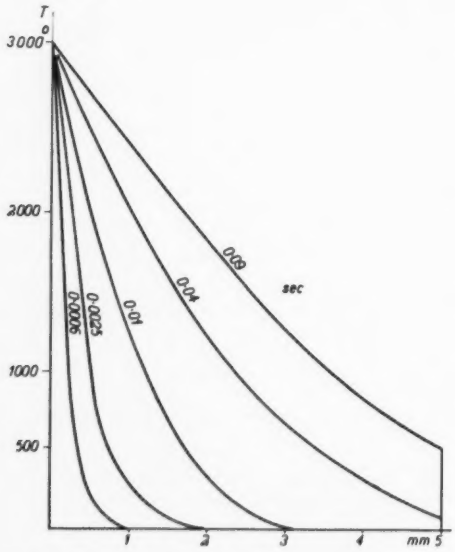

Fig. 2-*B*. Distribution of temperature in the anode during a falling load after different exposure times. Gradient at the surface decreasing.

[3] A. Bouwers, Verkürzung der Aufnahmezeit durch eine neue Belastungsmethode. Fortschr. a. d. Geb. d. Röntgenstr., 1933, XLVII, 703.

B. Automatic load-control.—The method of decreasing load has proven to be very useful, quite apart from the effect of reduction of exposure time which has just been described. To explain this fully, we will make a comparison between radiological technic and lighting technic. An incandescent lamp, used with its proper voltage, will automatically burn at a temperature which guarantees at the same time a reasonable lifetime and a good luminous power. It is not necessary to adjust the filament current, which would, by the way, be very difficult; it would certainly result in a considerable reduction of the life of the lamp and in most cases in a useless reduction of light.

We may say that an incandescent lamp is automatically charged at its limit capacity and this charge at limit capacity is of no less importance with an x-ray tube than it is with an incandescent lamp. Therefore, in the Philips Standard Unit the current is automatically connected with the tension in such a way that the wattage is the same for every exposure. The result is maximum output of x-rays and at the same time a guarantee for a reasonable lifetime of the tube. For apparatus of very short exposure times, however, there is a marked difference between the permissible load during, say, $^1/_{30}$ of a second and the permissible load during $^1/_3$ of a second, so that a constant wattage for every exposure would not be practical.

Here the decreasing load just described supplies an easy solution. If the load is such that the anode temperature is kept at its permissible limit during the whole exposure time, the exposure may be stopped at any moment and we may be sure that the wattage is well chosen for every exposure time and that, at the same time, the exposure is shorter than with normal load—thus maximum efficiency.

Figure 3 shows one of the newest apparatus for universal diagnostic work, which has, amongst several special features, this automatically decreasing load feature.

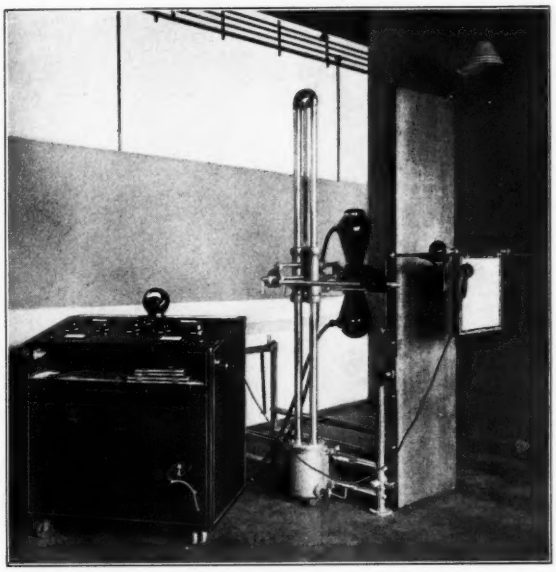

Fig. 3. New x-ray apparatus for universal diagnostic work. Voltage generator with new gas-valves and switch-table in one. Automatic loading system as described.

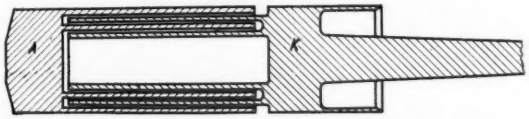

Fig. 4. Principle of the new rotating anode with "cooler." Heat dissipation by radiation.

C. Rotating anode tube with "anode cooling."—Rotating anode tubes give essentially better radiographs than tubes with stationary anodes. The rotating anode tube is used more and more for quickly moving objects and the improvement (eight times the load as compared with a stationary anode tube, both focal spots being equal in size) is so obvious that one is inclined to ask why its use is not even more general than it has heretofore been.

The recent improvement of the Rotalix tube has been to such an extent that now all radiographic and radioscopic work may be done by it. The difficulty has up to now been the "cooling." The freely rotating copper body will, after a certain number of exposures, reach a high temperature, and the dissipation of heat through the bearings, through radiation and through the surrounding gas molecules, is, of course, restricted. The construction shown in principle in Figure 4 brought the desired solution.

A number of cylindrical extensions of the rotating body have artificially blackened surfaces. Another set of cylinders, also with artificially blackened surfaces, has a good heat contact with the "cooling body."

Heat radiation from the anode cylinders is, at about 450° C., sufficient to transfer the energy of radioscopic work with intermittent radiographs to the fixed cylinders of the cooling body. The latter may, of course, be a radiator or a water reservoir or also a "mass cooler," as indicated in Figure 5.[4] This "mass cooler" has the considerable advantage of avoiding liquids or ventilators, the energy being momentarily stored up in the mass of the cooler with great heat capacity and then the mean energy is dissipated by convection and radiation. This new cooling system is now also applied in all Metalix shock-proof tubes.[5]

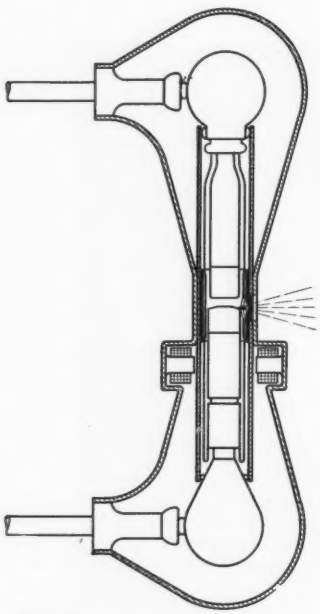

Fig. 5. Shock-proof and ray-protected "Rotalix" tube.

Fig. 6. Photograph of ray-protected "Rotalix" tube of Figure 5.

Figure 6 shows the shock-proof rotating anode tube, capable of doing all diagnostic work. It withstands the heaviest charge necessary for the very short long-distance chest films, and has, nevertheless, a fine focal spot.

D. A new high voltage rectifier.—High

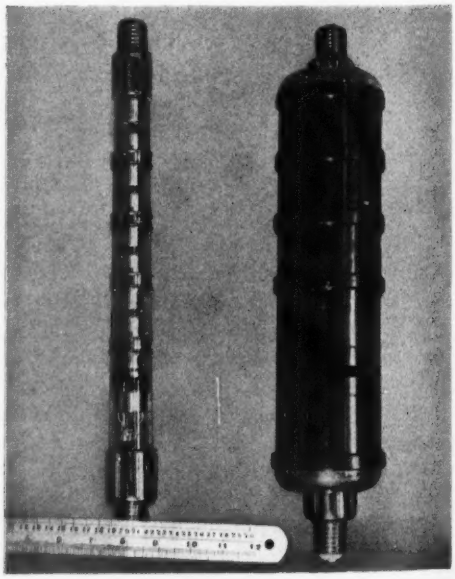

Fig. 7. New mercury high voltage rectifiers without and with condensers.

[4] A. Bouwers, Eine Röntgenröhre mit drehbarer Anode und "Anodenkühlung." Fortschr. a. d. Geb. d. Röntgenstr., 1933, XLVII, 232.

[5] A Bouwers, Ueber eine neue Anodenkühlung für Röntgenröhren. Fortschr. a. d. Geb. d. Röntgenstr., 1932, XLVI, 718.

vacuum rectifiers have contributed to a large extent to the progress of radiology, but they have disadvantages, as will be more clearly shown at the discussion of a new apparatus, which will be reported on later. What we have been trying to obtain are chiefly the following features: small voltage drop, large anode current, and low heating energy. These features are obtained with a new rectifier with gas discharge, of which a description will be given separately. The valve consists of a series of small discharge tubes containing mercury vapor, the first of which (cathode end) contains a filament for producing the electrons necessary to maintain the discharge.

To make sure that each step of the valve has equal voltage, condensers are arranged around them in series, each condenser in parallel with one of the steps. Figure 7 shows a valve without and with condensers.

Valves up to 200 K.V. have been constructed of reduced dimensions with practically no voltage drop, even at currents of the order of 1 ampere and a heating energy of a few watts only.

E. A new x-ray unit of very small dimensions.—Recent improvements have made it possible to build Metalix tubes, with practically an all-metal cylindrical exterior wall of very small dimensions. The metal wall may also be grounded with the great advantage that the tube may be put in contact with grounded parts of the transformer. In studying the way in which this feature can be best made use of, we arrived at the design shown in Figure 8. The iron of the transformer is arranged in a new way round the tube, as indicated. The primary and the secondary windings are in the circular opening, cut in the iron.

In this new transformer the electrical field between iron and secondary windings has no maxima as in ordinary transformers, so that sharp edges of an iron core are entirely avoided. Furthermore, no room is wasted, as will be seen from the drawings, so that weight and dimensions are as small as they possibly can be. The anode of the tube is in air, so its energy is not warming up the insulating material as it does in apparatus with tubes immersed in oil. The focus of the tube is in the center of the apparatus, which has proven to be of considerable advantage. Experiments show that the tube may even be

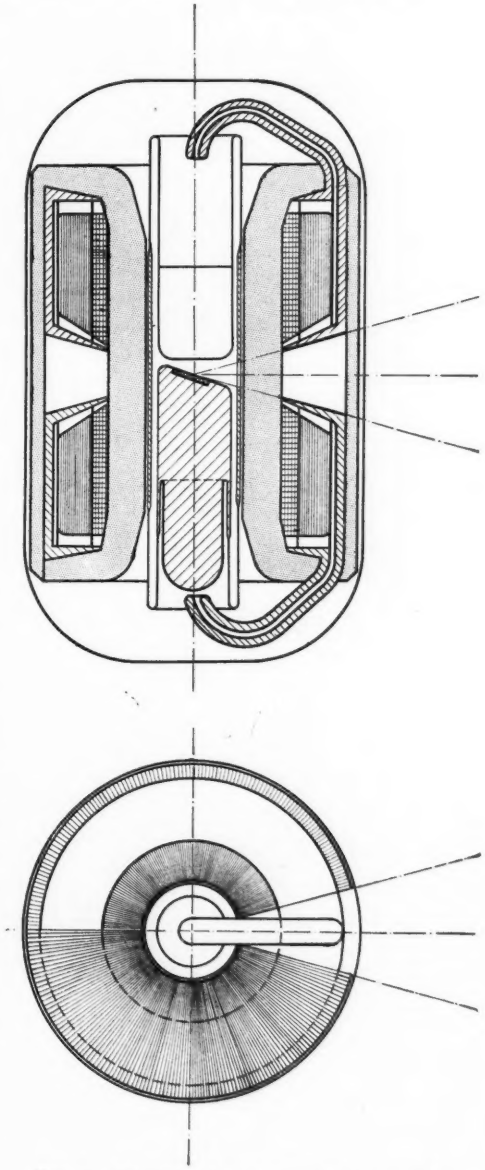

Fig. 8. Principle of new compact x-ray unit.

held in the hands during exposure, as with small movements the center of gravity tends to keep steady.

Two types of this new apparatus have of a transformer, a rectifier, and a condenser in series. The condenser is charged to a voltage which is the maximum of the transformer voltage. The so-called Grein-

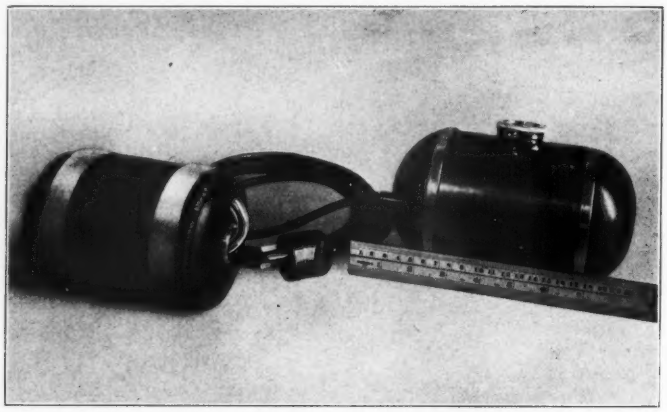

Fig. 9. Photographs of the smallest x-ray unit without and with mantle.

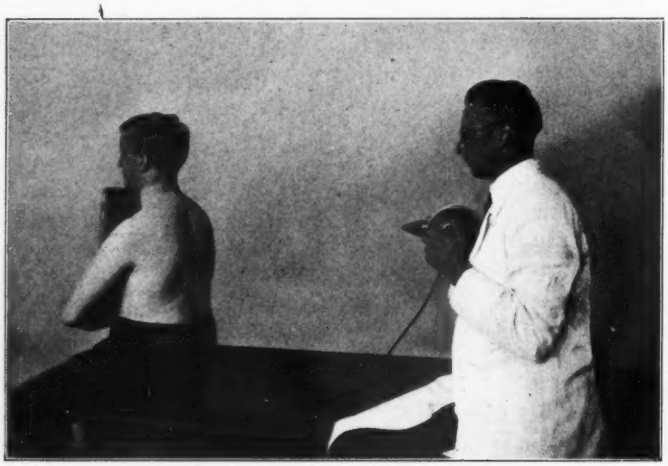

Fig. 10. Chest film taken with new unit.

been developed so far: a small dental type, weighing only about 12 pounds, and a portable type, weighing about 17 pounds. A more detailed description will be given separately, but Figures 9 and 10 show some further idea of the new apparatus.

F. A new high tension generator for very high voltages.—Well-known in therapy is the so-called Villard circuit, consisting acher and Witka circuits are, so to speak, only combinations of this Villard circuit. Now, consider the voltage on the valve of a Villard circuit. It is alternating and varying from zero to double the transformer value. Starting from this alternating tension, we may again build up a sort of Villard circuit with another valve and a condenser, provided we remember

that the cathode of the valve becomes only positive with respect to the anode. The new condenser will then be charged up to double the transformer tension and on the new valve we will find again a tension, varying between zero and the double of the

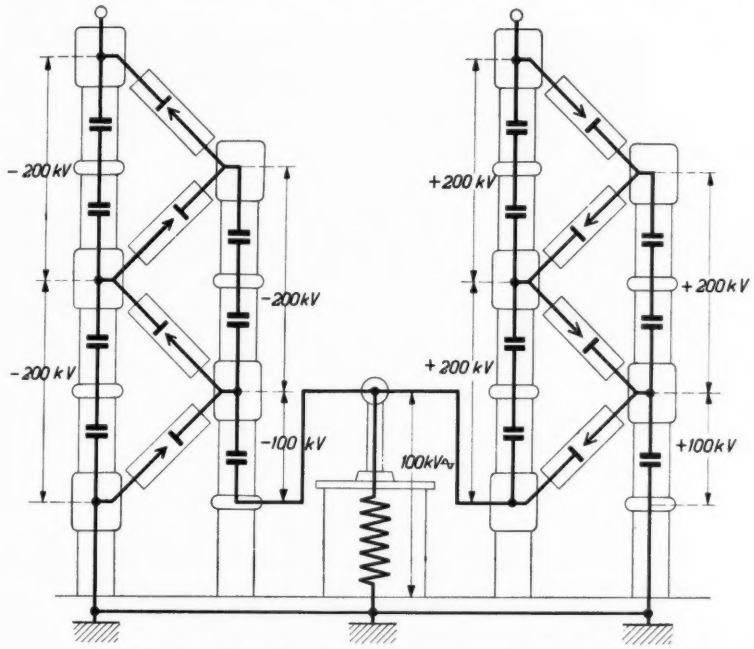

Fig. 11. Principle of cascade high voltage generator.

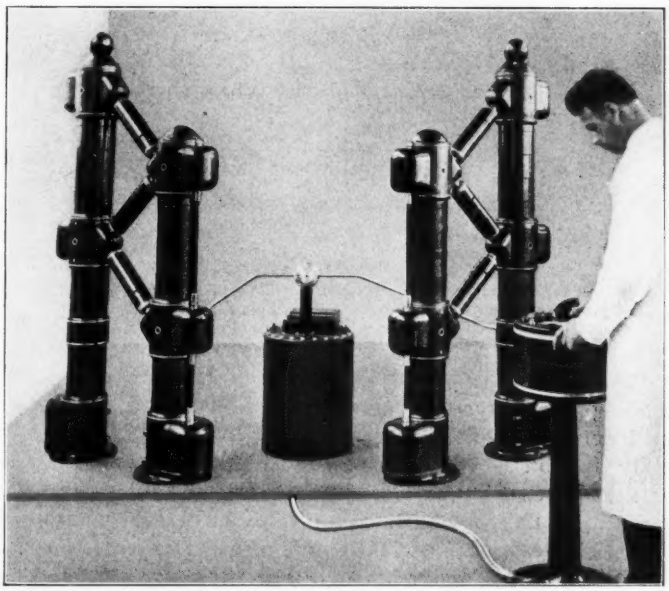

Fig. 12. Photograph of cascade high voltage generator as shown in principle by Figure 11.

transformer tension. So we can go on, as is shown in Figure 11. It is obvious that an advantage of this system is the possibility of extending the voltage by new units. The construction is such that this extension is easily possible.

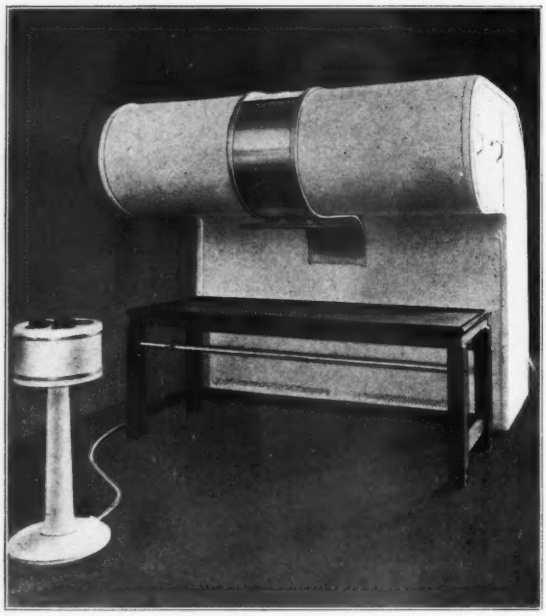

Fig. 13. Shock-proof high voltage generator and tube for 400 K.V. System of Figures 11 and 12.

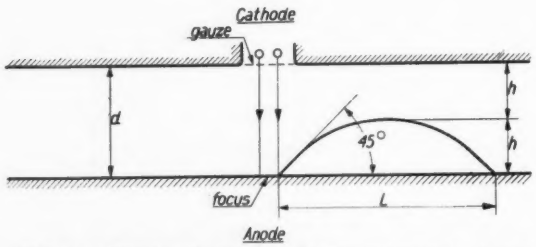

Fig. 14. Showing the principle of "limited reach." Large anode and cathode surfaces. Track of secondary electron starting with an elevation of 45°. Longest possible track.

It should be said here, that an early paper of Greinacher,[6] as long ago as 1921, contains in principle the essentials for this system, which somehow seem to have been forgotten. Recently Cockroft and Walton[7] in their report on their brilliant experiments on atom-splitting, gave a somewhat difficult description of a high tension apparatus, which is also a modified application of this new system. They apparently also found the system independently of Greinacher, whom they did not mention.

For the practical solution of this new

[6] Greinacher, Bull. d. Schweiz. Elektrot. Ver., 1920, XI, 59.

[7] J. D. Cockroft and E. T. S. Walton, Proc. Roy. Soc., 1932, No. 136, p. 619.

system it was, however, essential to possess new high voltage rectifiers. This was one of the reasons for our developing the new ments. One set was developed with accumulator batteries and automatic charging-up, but also a set with small insulated

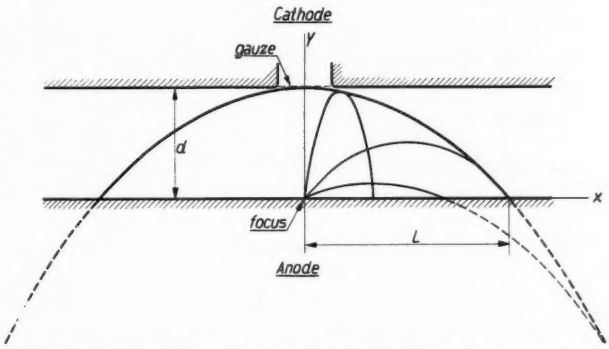

Fig. 15. More tracks of secondary electrons and the enveloping paraboloid.

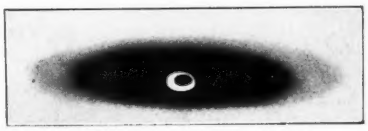

Fig. 16. Pinhole camera film showing the "limited reach" of secondary electrons, as described.

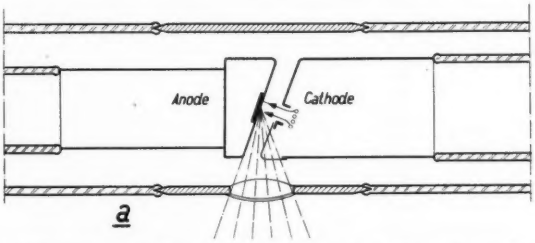

Fig. 17-*A*. Application of the principle of "limited reach" to an x-ray tube. The lower part of the cathode is very thin.

valves described above (D). It is obvious that the large anode current and the low voltage drop are of great importance, for the instantaneous value of the load currents in the valves near the transformer is many times larger than the currents used through the tube. Also, a low heating energy is of great importance, for now small batteries of accumulators may serve the few watts for heating the fila- motor-driven generators, as is seen on Figure 12. Both solutions have the advantage of avoiding highly insulated transformers, which would be fatal for the size of the set.

A set up to 800 K.V. was developed with a total height of only 8 feet and recently we succeeded in building a complete 400 K.V. set in a shock-proof form, complete with a tube, which may be placed in

any ordinary room and which is shown in Figure 13.

G. Self-protected Metalix tubes for 400 K.V. and more.—One of the difficulties encountered with x-ray tubes for very high voltages lies in the secondary electrons. They charge up insulated parts of the tube negatively. They may cause heat (each electron carries an amount of energy $^1/_2\ mv^2 = eV$) and ionization, electrolysis in the glass and also x-rays. In Metalix tubes their influence is restricted on account of the metal center part, which withstands the bombardment of secondary electrons fairly well, but for very high tensions it has proven necessary to avoid them. This is done by the new "principle of limited reach,"[8] which may be simply explained by referring to Figures 14 and 15. Every secondary electron

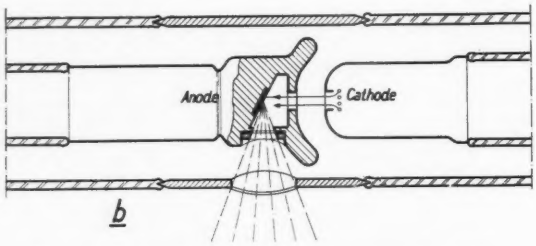

Fig. 17-*B*. Another application of the same principle.

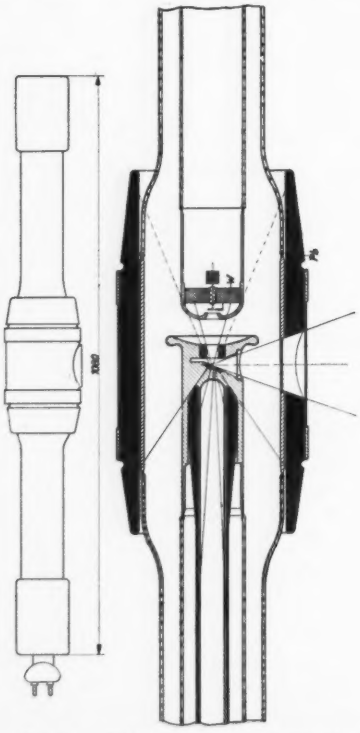

Fig. 18. Showing how x-ray protection is obtained in high voltage Metalix tubes up to 500 K.V.

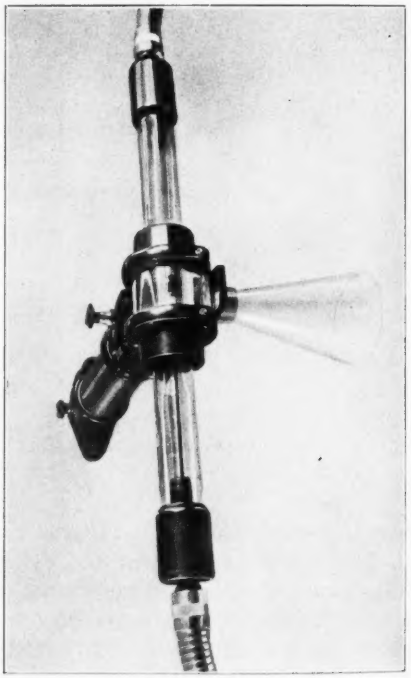

Fig. 19. Metalix tube with x-ray protection for 400 K.V. mounted on stand.

[8] Bouwers and van der Tuuk, Secundaire Electronen in Röntgenbuizen, Physica, 1932, XII, 274.

emitted by the focal spot will be attracted toward the anode by the electrical field. If anode and cathode have large parallel surfaces (Fig. 14), the electrical field is very simple and similar to the field of gravitation of the earth. We know from elementary mechanics that a bullet starting with an elevation of 45° has the largest reach and in our case of secondary electrons, it can be shown by elementary calculation that the maximum reach of a secondary electron is double the distance between cathode and anode. Therefore, to avoid secondary electrons in the tube, it is sufficient to give the cathode and anode surface a diameter which is at least four times the distance. Every electron follows a parabola and the envelope of all the parabolas forms a paraboloid of rotation, a section of which is shown in Figure 15. The limited surface, covered by secondary electrons, is shown in Figure 16, which is a pinhole camera picture of the anode. The focal spot has been covered with a piece of lead after a short exposure, to avoid too great density. The diameter of the covered area is exactly as calculated above and the picture, therefore, an experimental proof of the theory.

An almost equally simple calculation shows that there is also a definite "limited reach" in the case of two spherical electrodes. Figures 17-*A* and 17-*B* show the practical application of the two cases schematically in high voltage tubes. Application of this new principle made it possible to build a Metalix tube which is only slightly larger than the Standard 200 K.V. type for tensions up to 450 K.V. and there is no reason why a reasonable increase in size should not bring a tube for tensions up to 600 K.V. or more.

The protection problem with such tubes becomes of vital importance. It is, however, possible to accomplish sufficient protection in a comparatively simple manner. Figure 18 shows how protection is acquired equivalent to 15 mm. of lead in a 400 K.V. tube. The figure is, I think, almost self-explanatory. The cylindrical part in the anode is lead. It is outside the vacuum and the thickness is decreased so as to make the path of the x-rays through the lead equal to about 15 mm. everywhere.

At last, Figure 19 shows a commercial 400 K.V. tube with full x-ray protection.

I think that this type of tube, together with the generator just mentioned, can be easily worked out if biologic reasons should demand, to an artificial source α of radiation, which is ray- and shock-proof and so small that it may be placed in almost any ordinary room.

THE EFFICIENCY OF X-RAY STEREOSCOPY AS INFLUENCED BY THE METHOD OF TRIP OF THE TUBE

By PAUL M. ANDRUS, M.D., F.R.C.P. (Can.), *and* A. HAMBLETON, M.A., B.Sc., *London, Canada*

From the Mara Research Laboratories,[1] at The Queen Alexandra Sanatorium

IN a former publication (1) we have analyzed the relation of the position of the x-ray tube to the resultant sharpness of film images. It was shown in that study that for the attainment of a given degree of sharpness, a saving in energy of up to 22 per cent is possible by the correct positioning of the tube, as opposed to commonly used positions. The data there presented relate mainly to *single* exposures with the focal spot centered over the film. The correct method of placing and tripping the tube for *stereoscopic* exposures, from the standpoint of obtaining maximum sharpness, is, however, also shown, and is repeated for the convenience of the reader (*B*, Fig. 7).

The matter of stereoscopic agreement of the images was, however, not dealt with in the previous paper, and it is with this phase of stereoscopy that the present study is concerned. This paper thus aims to be supplementary to the foregoing study in presenting the effects of tube position for the special case of stereoscopic exposures, with special reference to the agreement of the stereoscopic images.

The question of the desirability or necessity of tilting the tube between stereoscopic exposures is also important to the practising roentgenologist. Some manufacturers offer, while others do not, facilities for such tilting. The roentgenologist must make a decision in the face of these conflicting recommendations, as to whether or not he should make expenditures for such a purpose.

NATURE OF STEREOSCOPIC ERRORS

The nature of the errors in stereoscopy which are to be examined will be clear from Figures 1, 2, 3. The object shown in these figures is thin and parallel to the film, a condition chosen because it simplifies the point to be discussed. In Figure 1 we have the desirable ideal condition in which the x-rays proceed from a true point, and it will be seen that the images cast on the films from the two stereoscopic tube positions are identical. In the x-ray tubes in common use, however, the rays proceed from an appreciable *area*—the focal spot—which lies at an angle to the surface of the film. As a result of these two factors the images cast from the two stereoscopic tube positions are no longer identical. In Figure 2 it will be seen that the image (marked *I*) from one tube position is much larger than that from the other, *i.e.*, the images undergo different *degrees of distortion*. The penumbral shadows (marked *P*) which determine the degree of sharpness of the images are also different from the two tube positions. Obviously, stereoscopic agreement can be no better than the geometric agreement of these two images.[2]

In Figure 3 the tube is so placed and so tilted during the trip that from each of the two positions the central ray of the tube travels toward the center of the object to be radiographed. It is clear from the figure that the images much more nearly approximate each other both in size and in degree of sharpness than they do under the conditions depicted in Figure 2. Perfect stereoscopic agreement is possible only when the unavoidable distortion and unsharpness of the images, due to the characters of the focal spot, are the same from the two tube positions.

Data concerning the efficiency of the

[1] Assisted by The National Research Council of Canada.

[2] The difference in size of the images resulting from the thickness of an object is, of course, an essential part of stereoscopic projection.

stereoscopic reproduction which results from each of several methods of tripping the tube will be presented herewith. A brief outline of the methods used to obtain these data follows, the lengthy mathematical calculations being omitted.

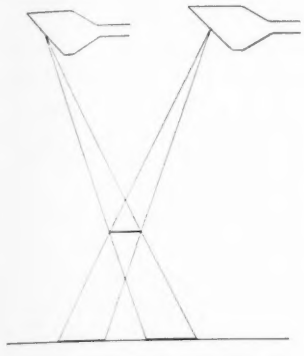

Fig. 1. Perfect stereoscopy resulting from a point source of radiation.

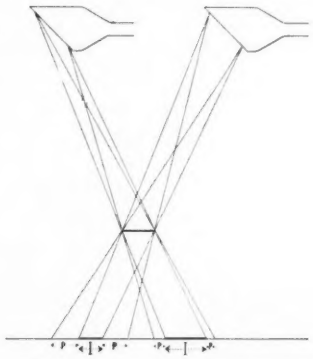

Fig. 2. Imperfect stereoscopy resulting from the use of a focal spot *area*.

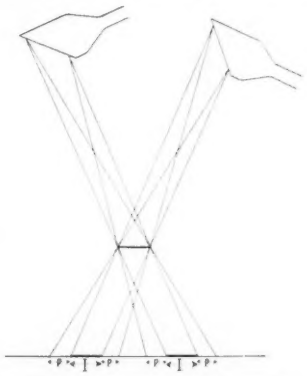

Fig. 3. Correction of imperfect stereoscopy by tilting the tube.

THE MEASUREMENT OF STEREOSCOPIC ERRORS

The errors in stereoscopy to which reference has been made can most easily be measured in terms of the change in the effective size of the focal spot that results when the tube is moved from the first to the second stereoscopic position. As described at length in an earlier paper, and illustrated in Figure 4 of this article, an object is radiographed by a focal spot whose effective size can be found by projecting in the direction of the object, parallel lines from all points around the focal spot onto the film. Thus from the tube position A in Figure 4, the point O would be radiographed with a focal spot whose effective size is A'; while from tube position B it would be radiographed with an effective focal spot size of B'. Thus although the actual focal spot size and slope at A and B are identical, it is apparent that the *effective* focal spot size with which the object O is radiographed is quite different from the two positions, and the consequent distortion and unsharpness of the images will be correspondingly different. In cases in which the focal spot of the tube is elliptical in shape, these effective focal spot shapes (or focal spot projections) are also elliptical, as shown at the lower edge of Figure 4, and at C, where they have been superimposed for clarity of description. Toward the margin of the film, as described elsewhere (1), the elliptical focal spot projections from the two tube positions differ not only in size but also in the slope of their axes, so that the focal spot projections fail to agree in the general manner indicated by the ellipses in Figure 5. It is the extent to which these effective focal spot sizes (or focal projections) fail to coincide which determines the measure of the stereoscopic error to be examined.

The *actual* sharpness and distortion of an image (in contra-distinction to the potential or theoretical characters) depend, in addition, upon factors which are beyond the scope of this article, such as the *actual* size, shape, and slope of the focal spot, and the ratio of the target-object to the object-film distance. Contrast and photographic visibility are further factors which influence the apparent definition or sharpness of the image. We are here concerned only with the *relative* efficiency of the various methods of placing and tripping the x-ray tube for stereoscopic exposures.

The methods for calculating the size and slope of the focal spot projections are detailed in the earlier article (1). Referring

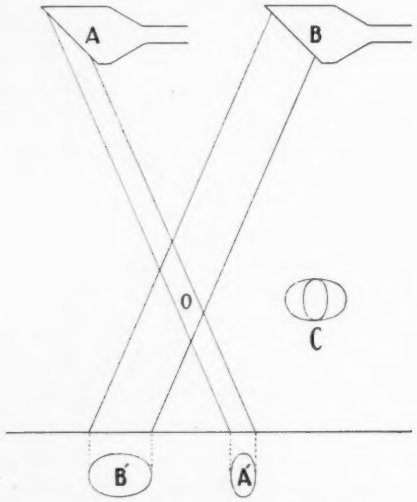

Fig. 4. Changes in the effective size of focal spot with which an object is radiographed from two stereoscopic tube positions.

to Figure 5, where the two ellipses represent the focal spot projections from the two stereoscopic tube positions (superimposed for convenience of description), and XY represents the direction of a linear structure to be radiographed, it is shown in that article that the effective size of the focal spot with which this linear structure is radiographed is given by the dimension AB in the case of one ellipse and by CD for the other ellipse. It will be noted that these dimensions AB and CD are the distances between parallel tangents to the focal spot projections,[3] and that the tangents run parallel to the edge being radiographed. The difference between these two dimensions AB and CD is the measure of the stereoscopic error for the point P on this linear structure, since this dimension governs the difference in sharpness and distortion between the two stereoscopic images.

Since in practical radiography the object to be examined will usually contain structures running in every possible direction, the stereoscopic error must be evaluated with reference to all possible directions of the linear structures. The calculation of the differences between parallel tangents to the two projection figures in all directions, however, proved to be an impossible mathematical task. It was necessary, therefore, to substitute a method of finite differences, and the calculation has been made for ten-degree intervals around the projection figures. By this means a fair average figure for the stereoscopic error at any point on a film may be evaluated by direct calculation. Since the stereoscopic error is widely variable over different parts of the film, we have presented figures for the average stereoscopic error at selected points on the film, namely, the center, the corners, and the mid-point along each edge.

TYPES OF STEREOSCOPIC TRIP

Since the object of this article is to compare the efficiency of various types of stereoscopic trip, let us now consider the most commonly used methods of tripping the tube, as depicted in Figure 6, wherein the dotted line indicates the direction of the central ray of the tube, while O indicates the central point of the object being radiographed.

At A is shown the commonly used longitudinal trip of the tube (also shown in Figures 1, 2, and 4 of this article). At B the tube is so placed and tilted during the trip that from both tube positions the central ray of the tube passes through the point O. As a result of the conditions shown at B, the stereoscopic errors at the point O are practically zero, as pointed out earlier (Fig. 3). In C and D, Figure 6, is shown the end view of the tube, the tube

[3] The distance between parallel tangents to an ellipse is given by $\sqrt{L^2\mathrm{Sin}^2\theta + S^2\mathrm{Cos}^2\theta}$ where L and S are the major and minor axes of the ellipse, and θ is the angle between the tangents and the major axis of the ellipse.

The other formulæ used in calculating the results given in this article are detailed in the earlier paper (1). Certain corrections must be applied to these formulæ when the tube is tilted or rotated from its normal position; the nature of these corrections will be obvious to those familiar with projectional geometry.

being tripped laterally, *i.e.*, at right-angles to the long arms of the tube; at *C* is shown the plain lateral trip, while at *D* the tube is so placed and rotated on its long axis during the trip that the central ray is projected in the direction of the point *O* from each of the tube positions.

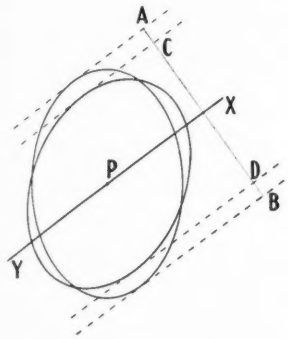

Fig. 5. Difference in the effective focal spot sizes (*A B* and *C D*) with which the point *P* on the linear structure *X Y* is radiographed from two stereoscopic tube positions.

Using the four types of trip described above, Table I gives the average stereoscopic error at selected points for an object of such size that it could just be completely radiographed upon 14 x 17 inch stereoscopic films. The other conditions used for the calculations are that the target-film distance is 30 inches, the object-film distance is 6 inches, the anode slope is 45° to the film, the focal spot is elliptical in shape, and the tube is tripped $2^1/_2$ inches, the target being equidistant from the center of the film at each tube position. The central ray projection of the tube is assumed to have a diameter of 100 units, and the figures given in Table I indicate in terms of these units the *difference* in the effective size of the focal spot with which the given points on the object are radiographed from the two tube positions. Thus if the tabulated difference is zero, the change in the effective size of focal spot is also zero. On each of the stereoscopic films there is then the same degree of sharpness and the same degree of distortion of the image, so that the two visual images fuse perfectly and perfect stereoscopy results. The larger the figures indicated in Table I, the more defective is stereoscopic agreement for the position specified.

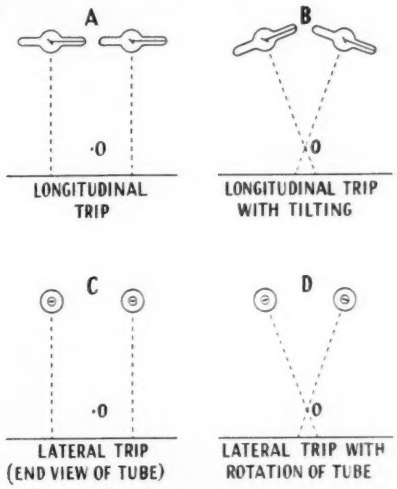

Fig. 6. Illustration of methods of tripping the tube as described in the text.

DISCUSSION OF METHODS OF TRIP

The stereoscopic efficiency resulting from these different methods of tripping the tube is shown in Table I. As noted above, the smaller the figure in these tables the better is the resulting stereoscopic agreement. The bottom row of figures gives the average efficiency for nine points on the film, the lower three positions in the table occurring twice.

It is apparent from these tables (Column 3) that much the best stereoscopic agreement is obtained by tripping the tube in its long axis, together with an appropriate degree of tilting, as illustrated in *B*, Figure 6.

It is important at this stage, however, to recognize that stereoscopic agreement is closely related to attained film sharpness. As the sharpness of the images approaches perfection, the significance of stereoscopic differences must become negligible. The

TABLE I.—DIFFERENCE IN STEREOSCOPIC PROJECTION USING VARIOUS TYPES OF TUBE TRIP

(The figures given are percentages of the central ray projection)

Film Position of the Image	Longitudinal Trip	Lateral Trip	Longitudinal Trip with Appropriate Tilting	Lateral Trip with Appropriate Rotation
Cathode center	7	4	0	0
Film center	7	7	0	0
Anode center	7	6	0	0
Cathode corner	14	9	3	5
Anode corner	16	7	2	7
Midlateral edge	14	8	2	5
Average over entire film	12	7	1.6	3.8

TABLE II.—TOTAL ANGLE THROUGH WHICH THE TUBE SHOULD BE TILTED OR ROTATED DURING THE STEREOSCOPIC TRIP

(Applicable to both 45° and line focus tubes)

Target to Center of Object Distance, Inches	Length of Tube Trip in Inches									
	1½	2	2½	3	4	5	6	8	10	12
18	4° 45	6° 20	7° 55	9° 30						
24	3° 33	4° 45	5° 57	7° 10	9° 30					
30	2° 52	3° 45	4° 45	5° 42	7° 35	9° 30				
36		3° 10	4° 0	4° 45	6° 20	7° 55	9° 30			
48			3° 0	3° 33	4° 45	5° 57	7° 10	9° 30	11° 30	
60				2° 52	3° 45	4° 45	5° 42	7° 35	9° 30	11° 20
72					3° 10	4° 0	4° 45	6° 20	7° 55	9° 30
84						3° 25	4° 5	5° 25	6° 47	8° 10

stereoscopic differences as here defined, relate to different methods of tripping the tube. They may or may not be important in the visualization of a given stereoscopic pair, depending upon whether the actual distortion and unsharpness in the images is negligible or important in degree.

Returning then to our selection of Column 3 in Table I as representing the best agreement between stereoscopic images, it will be observed that this method of placing the tube is in conflict with our previous recommendations, *i.e.*, that the long axis of the tube should always be placed along the shortest dimension of the film in order to attain the maximum sharpness inherent in the focal spot in use. Since then as above, sharpness of image should take precedence over stereoscopic agreement, it would seem that the method of tripping the tube which gives the next best agreement should be adopted. This occurs in Column 4, Table I, the tube being tripped in its own lateral axis along the long axis of the film and rotated between exposures as illustrated in *D*, Figure 6. This, then, is to be recommended as giving the best stereoscopic agreement consistent with efficiency as to sharpness and distortion of images.

If facilities for simply rotating the tube between exposures are not available, the next best stereoscopic agreement (Column 2, Table I) results from the same method of trip but without rotation of the tube between exposures. The commonly used method of tripping the tube in its own long axis and without tilting (Column 1, Table I) gives much the poorest stereoscopic agreement of all positions, as well, incidentally, as the poorest film sharpness. The 12 per cent error in agreement resulting from this method of trip may be expected to be within the visual range. However, we should repeat that these differences relate only to the *relative*

efficiency of different methods of tripping the tube and that if the actual sharpness of the images is excellent, the differences in stereoscopic agreement will not be important.

We are not yet in a position to define for practical use the actual geometric limits of visibility.

For convenience of the operator, the angle through which a tube must be tilted or rotated in order to project the central ray to the center of the object is given in Table II for various target-to-center-of-object distances and tube trips. This value is approximately contained in the formula

$$\text{Tan angle} = \frac{\text{Length of trip}}{\text{Target to center of object distance}}.$$

For stereoscopic exposures of long bones, such as the spine, wherein the trip is to be made at right-angles to the long dimension of the bone, the correct method of placing and tripping the tube is shown in *C*, Figure 7. This gives the greatest attainable uniformity of sharpness over the entire length of the image, but the tube should also be tilted when possible between these exposures.

STEREOSCOPIC EXPOSURES WITH LINE FOCUS TUBES

With line focus tubes, the effective focal spot size over the various parts of the film is always less uniform than with the 45° slope of anode. As pointed out earlier (2), both the steeper slope of the anode surface to the film and the more rectangular shape of focal spot in the line focus tube are contributory factors in producing this undesirable result. However, we are of the opinion that the increased tube capacity made possible by the line focus principle more than compensates for this defect. Correct positioning and tripping of the tube, as given in this and earlier publications (1, 2), are more important in the case of line focus tubes than with 45° anode tubes, since with the former a greater improvement in radiographic reproduction is attained by using the correct technic.

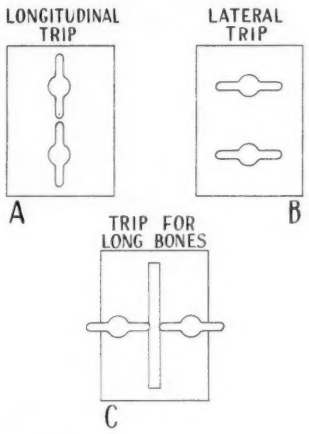

Fig. 7. Plan view of methods of placing and tripping the tube for stereoscopic exposures.

SUMMARY AND CONCLUSIONS

1. The principles governing the agreement of images in x-ray stereoscopic pairs, together with the relative efficiency of different methods of tripping the tube, are analyzed and tabulated.

2. The data are supplementary to a previous analysis of the most efficient position of the x-ray tube with reference to the film (1), but for the special case of stereoscopic exposures.

3. The best stereoscopic agreement (consistent with efficiency as to sharpness and distortion of images) is obtained by tripping the tube in its own lateral axis along the long axis of the film, while at the same time rotating the tube so that the central ray is in each case projected to the center of the object to be radiographed (*D*, Fig. 6).[4]

4. Stereoscopic agreement is 3 per cent better when the tube is so rotated than in

[4] See text for necessary exception in the case of long bones.

the case of the same trip without rotation, and should be attained, therefore, when mechanically feasible. In the presence of satisfactory sharpness of film images, however, this improvement in agreement is probably not within the range of visibility, and no outstanding trouble or expenditure seems to be warranted on this account at the present time.

5. Failure to place the tube correctly for stereoscopic exposures results in greater distortion and unsharpness of images than in the case of single films, and is more marked in the case of line focus tubes than for 45° anodes.

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PERFORATION OF PEPTIC ULCER FOLLOWING X-RAY EXAMINATION WITH A BARIUM MEAL

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ROENTGEN examination of the stomach with the aid of a barium meal is generally considered entirely innocuous, on which account barium studies of the stomach are employed more or less routinely and without discrimination or restriction. That this method of examination, however, is not altogether harmless is attested to by the number of cases in which radiographic investigation with a contrast medium is followed by acute perforation of a peptic ulcer. Publications dealing specifically with the subject of gastro-duodenal rupture as a sequel to the employment of the x-ray include 36 patients, 34 of whom had benign lesions and two malignant. Of the 34 perforated peptic ulcers, Panek reports eight, Eckman five, Hummelman four, Bittrolff three, Amberger, Colmers, and Nussbaum each two. Single instances are recorded by Ein Waldt, Frankenthal, Hijmans van den Bergh, Lang, Meijer, Rosenthal, Steiger, and Utili. Of the two carcinomatous ulcers which perforated following x-ray examination, one is reported by Lepennetier and Deruas and the other by Rovida. That the number of cases published under appropriate titles is by no means representative of the actual incidence is indicated by the frequency with which perforation following x-ray is mentioned incidentally in cases presented for other reasons. Casual mention of rupture occurring shortly after roentgenography is found, for instance, in the articles of Brütt, Dahm, Falta, Fermaud, Finsterer, Speck, and Wolfson and Gray, dealing primarily with other phases of perforated ulcer. Furthermore, there is evidence to show that experience with this accident is not confined to only a few but that it has been observed by many. Eckman states that after citing his five cases at a regional meeting of the American College of Surgeons, "Numerous admissions of such catastrophes were forthcoming." I have met with the same response at meetings where I have had occasion to mention my own cases.

Assuming that the cause and effect relationship between perforation and x-ray examination is a definite one, the question arises as to how serious a hazard is constituted by this diagnostic procedure. The only published statistical reports upon which to base an opinion are those of Panek, Hummelman, and Eckman. Panek writes that among 36 cases of perforated peptic ulcer observed in the Second Surgical Clinic of the University of Vienna between the years 1910 and 1926, eight followed roentgen examination with a contrast medium. These eight cases are divided by the author into two groups, the first including four cases in which rupture occurred within several hours of the x-ray observation, and the second group comprising the remaining four in which perforation followed after an interval of between 30 hours and six days. If the time element in Panek's series is disregarded, it is found that 22 per cent of his perforated ulcers followed the x-ray. If the second group of perforations is eliminated because of the questionable etiologic relationship, the percentage of ruptures occasioned by roentgenography still remains high (11.1 per cent). Among 17 cases of gastrointestinal perforation treated at the Surgical Clinic of the University of Bonn, five (29.4 per cent) occurred as sequelae to a barium meal. Hummelman, who submits the above report, states that during the time the five perforations were observed a contrast medium was administered by mouth to 1,500 individuals.

No mention is made of the number of ulcer patients in this group. The statistics of the Duluth Clinic, published by Eckman, includes five perforations in a series of 522 ulcer patients examined roentgenologically, an incidence of less than 1 per cent. The total number of perforations observed during the same period is not stated. At the Cook County Hospital only four perforations have been observed following x-ray examination during the past ten years. Within the same period of time over 500 perforated ulcers have entered the Hospital and more than 5,000 unruptured peptic ulcers have been examined radiographically. Based upon these figures the percentage of perforations which follow the x-ray examination is found to be only 0.8 per cent. Approaching the question from another standpoint, the incidence of perforation following examination of unruptured ulcers is merely 0.08 per cent. Judging from our own rather large group of cases, it appears that the hazard of perforation in connection with a barium meal is attended by relatively slight danger.

In considering the factors concerned in the production of a perforation, particular stress has been placed upon manipulation and compression of the stomach during the x-ray examination. The possible damage incident to manipulation by hand is exemplified in a case recorded by Albrecht. This author relates that a man of 40, while being examined with a barium meal, collapsed behind the screen on account of pain. Operation performed within an hour demonstrated, aside from a cholelithiasis, firm adhesions which stretched between the gall bladder and the duodenum and pylorus, and were partially torn. Compression of a given portion with the aid of a *Distinktor*, increasing, as it does, internal pressure, is especially dangerous in cases in which conditions are favorable for rupture. The rôle of the *Distinktor* and similar apparatus is emphasized by Mandl. In reviewing the individual case reports one is impressed by the large proportion in which an element of obstruction existed and in which, therefore, forceful compression was presumably employed. For instance, in connection with his third case Eckman writes: "It was only after a repeated hypodermic of atropin and rather forceful palpation that a large filling defect was noted in the duodenal cap." In two of my cases (Nos. 2 and 4) the examining roentgenologist recalled having employed unusually firm pressure in an attempt to visualize the bulb. The weight of the barium is generally considered to be less important in the etiology of the perforation than manual or instrumental factors.

Assuming as correct that forceful manipulation or compression and high specific gravity of the contrast medium induce perforation, the question naturally arises, Why is the accident of relatively uncommon occurrence? In other words, what are the predisposing factors which are absent in the overwhelming majority of ulcer patients and which condition the perforation in the small minority? One factor which appears to be highly significant is the status of the ulcer, namely, whether progressive or retrogressive. When an ulcer which has been healing for a time is subjected to the trauma incident to a barium meal examination, perforation is a rather remote possibility. If the ulcer has been penetrating the gastric wall and the base is approaching the serosa, other things being equal, x-ray examination is attended by a high coefficient of danger. Active extension of the ulcer, however, does not of itself explain the occurrence of perforation, for only a small percentage of progressive cases rupture as a result of a barium meal study. In order to account for the relative infrequency of perforation following x-ray examination, even in cases in which symptoms indicate progressive penetration, it is necessary to adduce a second factor—the location of the ulcer. When the lesion is situated on the lesser curvature or posterior wall of the stomach or duodenum, its extension beyond the serosa is usually into a neighboring viscus or other structure. The result is an extragastric penetration rather than a perfora-

tion. A posterior wall ulcer may rupture into the omental bursa, but this is a relatively rare occurrence. As a rule, it is an ulcer located on the anterior wall which perforates into the free abdominal cavity. Since only 5 per cent of all ulcers are situated on the anterior wall (Boas), barium studies can be made in about 95 per cent of the cases with active progression with little or no hazard of perforation.

In reviewing the case histories of patients who perforated following a barium meal study one is immediately impressed by the number of patients in whom an intensification of previous symptoms preceded the x-ray examination. This fact, of course, should occasion no astonishment, since the average patient seeks medical advice only when his pain no longer yields to the usual household remedies. Because roentgenography is universally considered an integral and essential part of the "work-up," in clinics and hospitals particularly, it is during the stage of active extension of the ulcer that examination is generally performed. The occurrence of an aggravation of previous symptoms is of more than casual interest, since it may indicate active extension and, therefore, potential perforation. The assumption that an intensification of the usual manifestations of ulcer is indicative of penetration toward the peritoneal coat is based upon observations in patients who perforate spontaneously. Several authors (Federmann, Finsterer, Leube, Moynihan, Ryser, and Walton) have emphasized the presence of prodromal or inaugural symptoms in cases of perforation which occurred from no apparent cause.

From the practical standpoint, it is important to identify, if possible, those patients in whom x-ray examination with barium is attended by the hazard of perforation. The two tangible factors which contribute to rupture following roentgenography are location on the anterior wall and active extension of the ulcer. With regard to determining the location of an ulcer by clinical means little can be expected. Pain referred to the back is usually associated with posterior wall ulcer, but dorsal radiation is frequently lacking. Although tenderness and rigidity are described in connection with "perforating" anterior wall ulcers, these physical signs are generally absent until after perforation has actually occurred. Since the location of the ulcer cannot be predicted, recognition of the cases which are ill-suited for barium meal study must be based upon clinical evidences of progressive penetration. This is indicated by an intensification and increased refractoriness of the patient's usual ulcer symptoms. If x-ray examination with barium is withheld from ulcer patients with clinical manifestations indicative of penetration, the danger of perforation following roentgenography will be greatly reduced. Energetic ulcer treatment at this time will generally initiate processes of healing and render the ulcer inactive in a comparatively short period. In the stage of retrogression the x-ray procedure is attended by relatively little danger and can be more thoroughly and satisfactorily carried out. When a barium meal examination is considered essential and is undertaken in spite of the presence of prodromal symptoms, the suggestions made by Panek should be observed. This author advises, in the presence of a recent exacerbation of an ulcer, the two following precautions: (1) less barium in more fluid; (2) elimination of the *Distinktor* and only gentle palpation to aid in distributing the barium rather than to compress the stomach.

The four cases of perforation following a barium meal which came to the author's attention are summarized below. In each instance the x-ray examination was performed at a time when the ulcer was actively penetrating, as indicated by recent intensification of previous symptoms. In all four patients forceful manipulation was employed in an attempt to visualize the lesion. In two (Cases 1 and 3) the perforation was not diagnosed at the time of its occurrence and consequently operation was not performed. Failure to recognize the presence of an acute rupture was due to

the atypical clinical picture which followed the intense initial pain. The symptoms manifested in the post-perforative stage were those of mild localized peritonitis conditioned by early spontaneous closure of the hole, which limited the quantity of extravasated material (see Singer and Vaughan). It is quite likely that additional *forme fruste* perforations have followed x-ray examination but, having excaped recognition, have not been recorded.

CASE REPORTS

Case 1. M. A,. male, white, 34 years of age, entered the Cook County Hospital Oct. 3, 1924, with a history of chronic ulcer symptoms extending over a period of two years. During the week prior to admission he experienced an increase in the intensity and persistency of his previous pain, and, in addition, suffered for the first time from vomiting. The following day a barium meal examination was made and after forceful compression of the stomach merely a prepyloric elongation was detected. Three hours after completion of the fluoroscopic examination the patient developed typical symptoms of perforation, which, however, were not correctly interpreted by the interne on the service. Gall-bladder disease was suspected, based mainly upon the radiation of pain to the right shoulder and predominance of physical signs in the right upper quadrant. Exploratory operation, performed Oct. 18, 1924, fifteen days after the onset of violent pain, disclosed the pyloric region of the stomach to be intimately attached to the under surface of the liver. After separation of the adhesions a prepyloric ulcer which appeared to have perforated, was exposed. Contained within the adhesions was a small quantity of barium. The perforation was sutured and a gastro-enterostomy performed. The recovery was uneventful.

Case 2. G. B., white man of 45, entered the Cook County Hospital on May 8, 1927, complaining of epigastric pain which had troubled him daily for a period of two months. Prior to ten days or so before admission the pain had been readily relieved by baking soda or food, but during the one and one-half weeks before entering the Hospital the distress was not amenable to the usual measures. On May 10 the patient was radiographed with the aid of a barium meal and a duodenal deformity characteristic of ulcer was observed. An excessive amount of manipulation was employed in order to demonstrate the lesion to the satisfaction of the attending physicians and internes present. Fourteen hours after fluoroscopy the picture of an acute perforation supervened. Operation performed within an hour disclosed a hole on the anterior wall of the duodenum, with the usual type of extravasated material and exudate, unaccompanied by any barium.

Case 3. This case was reported some time ago as an example of spontaneous recovery following perforated peptic ulcer, at which time, for the sake of brevity, only that evidence pertaining chiefly to the subject discussed was mentioned. On this account the severity and refractoriness of the pain which led the patient to enter the hospital was not included in the published record, which is reproduced herein.

G. J., a colored man, aged 49, admitted to the hospital on Aug. 20, 1928, complained of periodic distress of an ulcerous type of one year's duration. Roentgen examination, on the morning of Aug. 30, entailed considerable manipulation of the stomach in an attempt to overcome a pyloric obstruction. That evening, intolerable epigastric pain developed, shortly after which vomiting and hiccup occurred. The right upper abdominal quadrant was rigid and tender. Morphine afforded relief. Slight fever and a leukocytosis of 16,000 developed the next day, followed by rapid subsidence of symptoms and signs. Operation, performed on Sept. 15, disclosed a perforation of the pylorus, securely covered over by the gall bladder, which formed the floor of the ulcer. The texture of the adhesions corresponded to the time which had elapsed since the acute

pain of sixteen days previously. The perforation was sutured and cholecystectomy and gastro-enterostomy performed. The patient recovered.

Case 4. J. A., a white man of 39, had suffered periodically from ulcer symptoms since 1923. Beginning about Nov. 1, 1930, he noted a change in his usual symptoms, the pain becoming more intense and more persistent than formerly and it no longer disappeared following the intake of sodium bicarbonate. In addition, he suffered from frequent vomiting, a symptom which had not troubled him previously. He reported to the Out-patient Clinic on Nov. 13, 1930, when a barium meal was scheduled for the following day. On Nov. 14, two weeks following the beginning of the aggravation of pain and the appearance of vomiting, he was examined roentgenologically in the routine manner. On account of a persistent pylorospasm, associated with a noteworthy degree of organic obstruction, the bulb was not readily visualized. The attempt to force barium into the duodenum entailed an undue amount of vigorous compression.

Fig. 1. Case 4. Pneumoperitoneum due to perforation of a peptic ulcer which occurred 15 hours after x-ray examination of the stomach with barium. With the patient in the left lateral position, the air is seen to accumulate beneath the right lateral wall and to displace the liver downward. The contrast meal has passed into the colon.

On Nov. 15, 1930, at 1 A.M., 15 hours after the fluoroscopic examination, the patient developed the typical symptoms of an acute perforation. He arrived in the hospital at 7 A.M., with classical signs of a ruptured, air-containing viscus. *En route* to the operating room the patient was fluoroscoped and films were taken (Fig. 1). At the operation, performed shortly after 8 A.M., a perforation was found on the anterior wall of the duodenum near the

lesser curvature close to the pylorus. For a distance about the aperture the wall of the duodenum was thickened and indurated. No barium was observed in the peritoneal cavity. The hole was sutured, covered by omentum, and a posterior gastro-enterostomy performed. The patient made an uneventful recovery and was discharged Dec. 1, 1930.

SUMMARY AND CONCLUSIONS

The relatively large number of reported gastroduodenal perforations which have occurred following x-ray examination with barium seems to indicate a cause-and-effect relationship. The number of ruptures following roentgenography as compared with the total number of perforations observed within a given period in two foreign clinics is surprisingly large (University of Vienna, 11.1 to 22.2 per cent, University of Bonn, 29.4 per cent!). These figures, based upon relatively small series, lead to the assumption that a barium meal study is comparatively hazardous. Statistics, based on extensive material at the Cook County Hospital, show that only 0.8 per cent of the total number of perforations were preceded by radiography.

The factors concerned in the production of a perforation pertain to the roentgen examination and the ulcer. The important factors in the x-ray investigation are manipulation and compression of the stomach, both manual and instrumental, while of far less significance is the specific gravity of the barium. From the standpoint of the ulcer the location and status (progressive or retrogressive) of the lesion are to be stressed. In general, only those ulcers situated on the anterior wall of the stomach and duodenum perforate into the free abdominal cavity, and posterior wall ulcers as a rule penetrate into a neighboring structure or organ. The status of the ulcer is also of import, since a healing lesion is far less liable to perforation than one which is actively extending toward the serosa.

Ulcer patients generally seek medical advice at a time when the symptoms are more severe and more refractory than usual, and it is then that x-ray examination with barium is ordinarily undertaken. There is evidence to show that an aggravation of customary ulcer symptoms indicates active progression of the lesion and may represent the prodromes of an impending perforation. It is of importance, therefore, in a patient with a history of recent intensification of symptoms, to postpone radiography whenever possible and to first institute ulcer management. If x-ray examination is deemed necessary and is carried out in spite of the presence of an exacerbated symptomatology, care should be exercised with regard to palpation and the specific gravity of the barium administered.

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CORRELATION OF ROENTGEN AND PATHOLOGIC FINDINGS IN PERTHES' DISEASE

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SINCE Zemansky (1) and Lippman (2) described the pathologic findings in the femoral heads in Perthes' disease, describing each a case and reviewing the 11 microscopically examined cases previously reported in the literature, we have been impressed by the closeness with which the roentgen findings in many cases of Perthes' disease follow the pathologic descriptions.

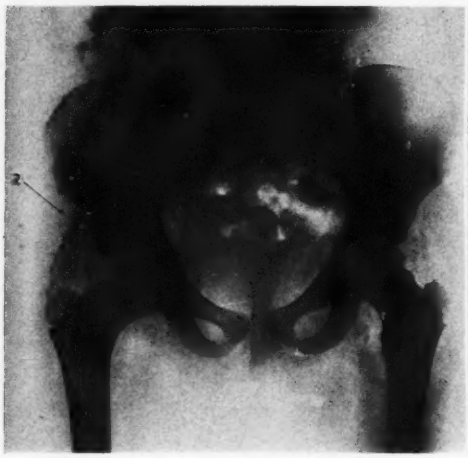

Fig. 1, Case 1. Massive subchondral bone and marrow necrosis in femoral head (*a*). Zone of granulation tissue and fibrous tissue replacement, later containing osteoid tissue and repair bone (*b*). Absence of narrowing of joint space indicates intact surface cartilages. Epiphyseal cartilages probably involved in this case. Note that the necrosis is far in excess of the reparative processes (Oct. 25, 1927).

Fig. 2, Case 1. Roentgenogram taken March 15, 1928.

These authors found the outstanding features of this disease to be massive subchondral bone and marrow necrosis in the developing femoral head. The surface cartilage was intact. The condition of the epiphyseal line varied—sometimes intact, sometimes interrupted, or completely destroyed. The presence of granulation tissue was constant. In cases of moderate duration, osteoid tissue was found growing into the granulation tissue. In one old case, of eight years' duration, solid bone was found, representing the extent of spontaneous healing. Sequestra were found in three cases, though I must confess the distinction between massive bone necrosis and sequestrum is not clear in my mind. Zemansky calls attention to the small amount of spontaneous healing in comparison to the large area of necrosis.

Omitting all reference to, and discussion of, etiology, which controversial subject we do not care to consider at this time, Zemansky's conception of the course of Perthes' disease is as follows: necrosis of subchondral bone and marrow. The necrotic bone is readily fractured by weight-bearing, with resultant deformation of surface contour. Repair is slow, by means of fibrous tissue replacing the bony fragments. A small amount of osteoid tissue is formed

Fig. 3, Case 1. Roentgenogram taken Aug. 11, 1928.

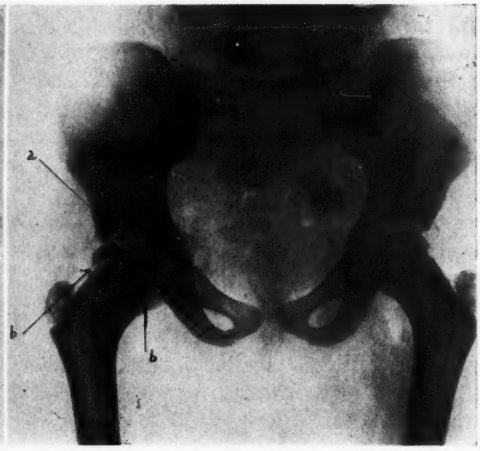

Fig. 4, Case 1. Roentgenogram taken April 20, 1929.

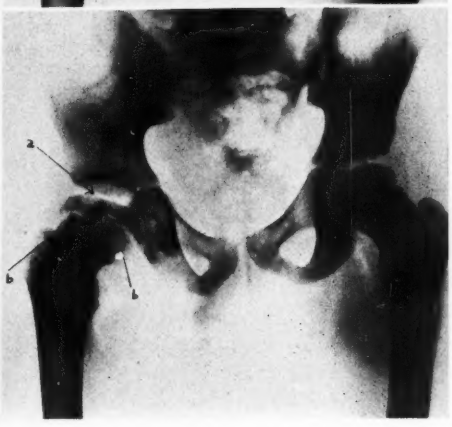

Fig. 5, Case 2. Shows same conditions and course as Case 1. (Feb. 1, 1930.) (*Above.*)

Fig. 6, Case 2. Roentgenogram taken May 3, 1930. (*Above.*)

Fig. 7, Case 2. Roentgenogram taken Aug. 21, 1930. (*Below.*)

Fig. 8, Case 2. Roentgenogram taken Jan. 17, 1931. (*Below.*)

from the fibrous tissue and by the surrounding live bone lamellæ, but the blood supply of the region is too inadequate to bring about solid replacement. Eventually, as the child approaches adult life, an equilibrium is reached in which the blood supply is able to take care of whatever is left of the epiphysis. Just how long it takes for the entire involved area to become solid can only be surmised.

We have selected the roentgenograms of two very typical cases of Perthes' disease for use in calling attention to the closeness with which the roentgen course follows the pathologic descriptions.

In the earlier films appears the massive subchondral bone necrosis, manifested by the increased sequestrum-like density of the areas of bone in the femoral heads. At this time, and throughout the course of the disease, the intact condition of the surface cartilages is attested by the absence of any narrowing of the joint space. In these two cases that are being shown, the epiphyseal cartilages are probably involved.

In the later films, the necrotic bone mass or ma sses) gradually diminishes in size through absorption, and becomes surrounded by a clear zone, the zone of granulation tissue and fibrous tissue replacement. In some of the older cases, there is doubtless also osteoid tissue in this surrounding zone. In the final few films of the series, the density of the zones surrounding the necrotic bone is greater than that of fibrous and osteoid tissue, and indicates the presence of repair bone. The flattening and deformity of the heads, with their diminished size, support Zemansky's pathologic observation that the necrosis is far in excess of the reparative processes.

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SUMMARY

The agreement of roentgen findings with pathologic findings in Perthes' disease is discussed.

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AN X-RAY STUDY OF THE POST-OPERATIVE STOMACH[1]

By JOHN R. CARTY, M.D., SYDNEY WEINTRAUB, M.D., and ROBERT K. FELTER, M.D., *New York Hospital, New York City*

THE following paper is an analysis of 144 cases of peptic ulcer which have received surgical treatment. This material represents the work of many different surgeons employing various technics and, we believe, presents a fair cross-section of gastric surgery for this condition. Each patient was interviewed personally, a careful history was taken, and a physical examination was made. In the beginning of this study each patient received a fluoroscopic examination only, but as the importance of the work became apparent, each was also plated. Most of these patients have been seen both before and after operation, and many of them have been under observation for as long as ten years. The clinical results have been judged by the patients' statements as to their symptoms and ability to continue with their routine of life. We will endeavor to show that the x-ray examination of the post-operative stomach is of importance for the following reasons:

1. That there is a definite correlation between the radiographic findings and the clinical results.

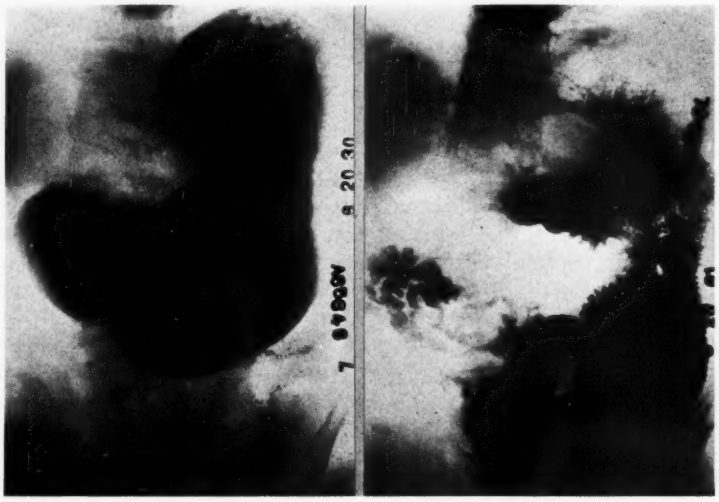

Fig. 1. (A 65,346.) (*A*) Pre-operative; post-pyloric ulcer, with obstruction. (*B*) Ten months after posterior gastro-enterostomy. Good clinical and radiographic result. Stomach has diminished considerably in size, occupying a higher and more lateral position.

2. That, by means of an x-ray study, one can prognosticate a good or a poor clinical result.

3. That the radiologist can be of assistance to the surgeon in pointing out the causes for some of the poor results obtained in gastric surgery.

Although the appearance of the post-operative stomach varies according to the type of operative procedure employed, nevertheless, there are certain striking characteristics common to all that are functioning well and producing no symp-

[1] Read before the Radiological Society of North America at Atlantic City, Nov. 28–Dec. 1. 1932.

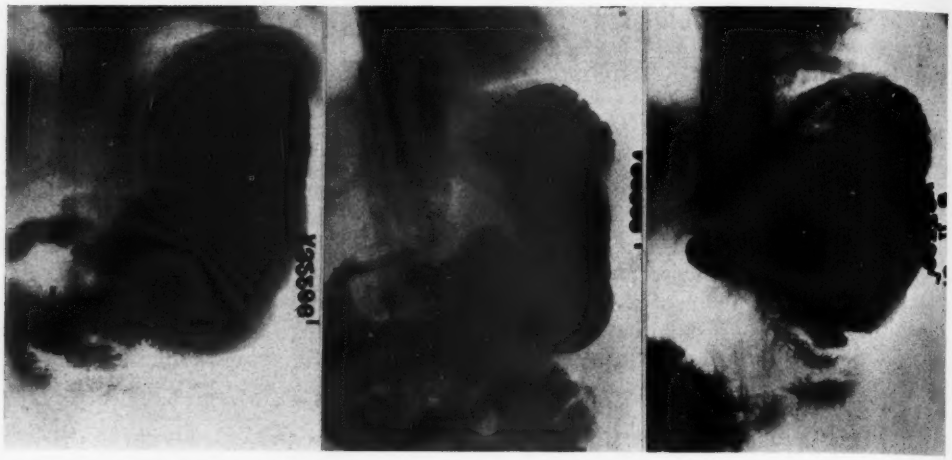

Fig. 2. (A 32,266.) (*A*) Pre-operative; post-pyloric ulcer. (*B*) Two months after posterior gastro-enterostomy. Stomach has not diminished very much in size. (*C*) Eight months post-operative; stomach increasing in size and losing its tone. Patient has had return of symptoms.

toms. In the first place, it is a much smaller stomach and occupies a higher and more lateral position. Secondly, the peristaltic activity is diminished and there is a lessening of mobility. Finally, the emptying of the stomach is much more rapid. In the types of operations depending on a new opening in the stomach, that is, the gastro-enterostomies and various types of resection, the stoma should be so placed that free drainage is maintained. In our series of posterior gastro-enterostomies, the stomata which were placed near the pylorus gave the best clinical results. The size of the stoma is also important, the larger the stoma the better the drainage. Rapid emptying of the post-operative stomach appears to be desirable and in not one of our cases did this produce untoward symptoms such as diarrhea.

Deviations from the above criteria are apt to coincide with poor clinical results, the most important of these being the size of the post-operative stomach. If there has not been a considerable diminution in size, it is a sign of poor drainage and the patient is more apt to have a poor clinical result. Poor drainage is due to the following causes: (1) the stoma being too small; (2) poor placement of the stoma; (3) the proximal loop of the anastomosis is too long; (4) a kinking of the distal loop at the mesocolon. It was found that if any of the above factors existed, the stomach not only failed to diminish in size but in many cases actually increased in size. In the dilated, obstructed stomach the stoma should be placed near to the pylorus and made especially large because, when the stomach shrinks, the stoma will diminish in size and will be drawn upward and to the left. We have all seen the stoma placed at the fundus of the stomach and probably have wondered what the operator had in mind! Another error is the allowance of a too long proximal loop, which will hinder drainage and may establish a vicious cycle. It is interesting to note that in the cases in which severe hemorrhage occurred a considerable time after operation, there being no signs or symptoms of a recurrent ulcer, we found that either the stoma was too small or that there was obstruction to the distal loop. A possible explanation, which we venture to give, is the formation of varices at the stoma, due to narrowing of the stoma itself or to adhesions which produce obstruction to drainage. Some surgeons have a predilection for placing the stoma about two

inches proximal to the pylorus, a type of operation in which the opening behaves like a new pylorus, so that the stomach does not empty so rapidly and there is, in consequence, not so marked a diminution in size. The clinical results have been found to be good in this type of procedure.

As has been stated previously, the peristalsis of the normal post-operative stomach is considerably diminished. An in-

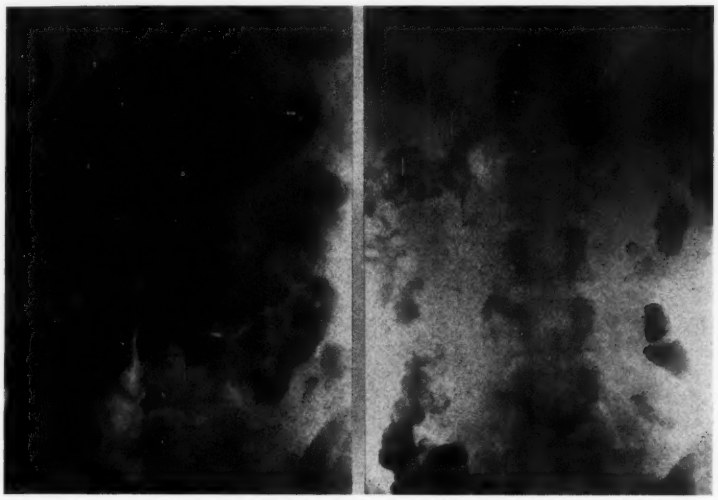

Fig. 3. (1,419.) (*A*) Posterior gastro-enterostomy for post-pyloric ulcer two years after operation. Patient had developed a severe gastric hemorrhage. Note large active stomach. (*B*) Showing a 9-hour gastric retention. Note narrowing of stoma resulting in poor drainage.

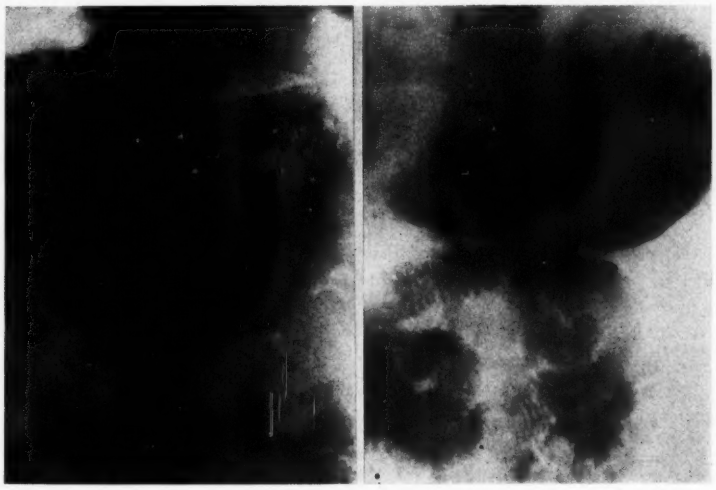

Fig. 4. (A 37,600.) (*A*) Before operation; post-pyloric ulcer and diverticulum of the second portion of duodenum. (*B*) Two years after posterior gastro-enterostomy. Note increase in size of stomach due to too long a proximal loop. Patient has no clinical symptoms.

crease in peristalsis may be the first indication of difficulty and usually precedes the increase in the size of the stomach. Besides, the increase in activity forces the stomach contents through the old route, *i.e.*, the pylorus, and may be the cause for the reactivation of an apparently healed duodenal lesion.

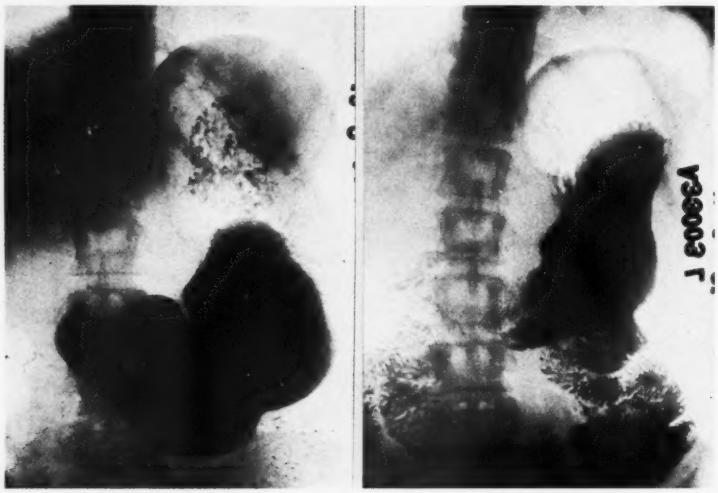

Fig. 5. (A 33,003.) (*A*) Before operation; pyloric ulcer, with obstruction. (*B*) Three years after Billroth II resection. Good clinical and radiographic result; good drainage maintained. Note diminution in the size of the stomach.

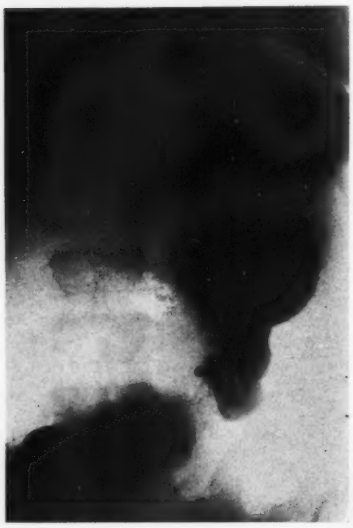

Fig. 6. (21,708.) (*A*) Billroth II resection for pyloric ulcer. Note marginal ulcer, increase in tonus and activity of stomach, also spasm of distal loop.

Fig. 7. (59,035.) (*A*) Polya resection for pyloric ulcer; good clinical and radiographic result. Note size and shape of stomach; good drainage established.

Without knowing the identity of the patients, radiographs of 96 were studied.

79 were posterior gastro-enterostomies for duodenal or pyloric ulcers
1 was for gastric ulcer
9 Polya resections for gastric ulcer
4 Billroth II resections for gastric ulcer
2 pyloroplasties for duodenal ulcer
1 anterior gastro-enterostomy for marginal ulcer

From the roentgenologic point of view, the cases were divided into two groups, (*a*) good results, and (*b*) poor results. In 84 per cent of the cases the x-ray observations corroborated the clinical results. In 16 per cent the x-ray findings suggested a poor result but this was not verified clinically during the time the patient was under observation. It is our impression, however, that a goodly percentage of the latter will eventually develop difficulties.

The poor results from a radiographic point of view fell into two groups:

1. Those with a disturbance of the mechanical factors, *i.e.*, too large a stomach, poor emptying, over-activity, or poor placement of the stoma. In this group there were 26 posterior gastro-enterostomies, two Polya resections, one Billroth II resection, and one pyloroplasty. There was also one case in which both an excision of a gastric ulcer and a pyloroplasty for duodenal ulcer were done, which illustrated the shortening of the lesser curvature following excision. We also felt that a posterior gastro-enterostomy would have been a better surgical procedure in this case. It is this group, in which poor mechanical results have been found, that we wish particularly to emphasize, because it is here that the roentgenologist can point out not only the causes for the poor result but often predict it. He can also be a factor in reducing the number of poor post-operative results by pointing out to the surgeon the importance of the mechanical factors in gastric surgery.

2. Into the second group of poor results fall the unfortunate cases which have developed marginal ulcers, formed new ulcers at different sites, reactivated the original ulcers, or developed severe gastric hemorrhages. There were 13 posterior gastro-enterostomies and one resection in this group. These cases are also often associated with poor mechanical function. Although we cannot presume to say that poor mechanical function is a cause for the formation of new ulcers, nevertheless we feel that at times it possibly is an important factor. We have also noted a peculiar spasm of the proximal loop in marginal ulcers which impedes the emptying of the stomach. This sign may have some diagnostic significance.

Fig. 8. (29,570.) (*A*) Polya resection for pyloric ulcer; poor clinical result. Note that stomach is too large; drainage is poor because of too long a proximal loop.

The x-ray technic employed in the examination of the stomach has often been discussed. It will suffice to say it is essential that the examiner be aware of the fact that the patient has had an operation before beginning his examination. It is important to follow the first swallow of barium in order to obtain a good conception of the channels through which it passes. Marginal ulcers are identified by a constant fleck of barium at or near the site of the stoma. Tenderness of this

fleck is usually present. These ulcers may be overlooked if the stomach is too full of barium, and at times can be demonstrated only during the fluoroscopic examination.

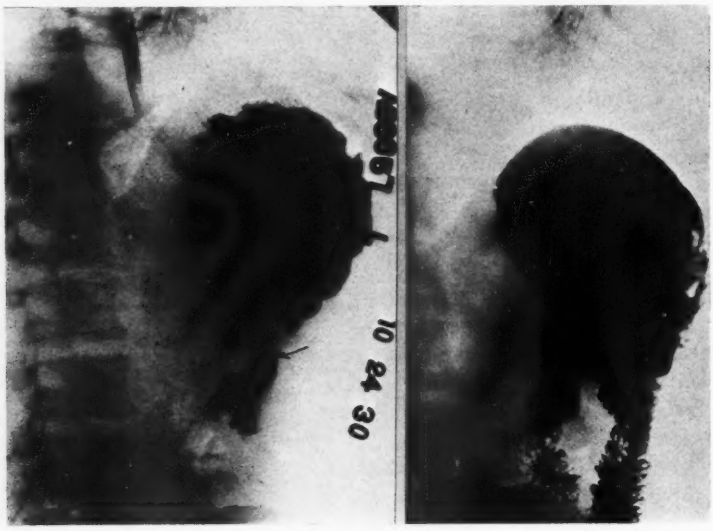

Fig. 9. (A 6,865.) (*A*) Posterior gastro-enterostomy for post-pyloric ulcer. Recurrent ulcer in distal loop. Note spasm of jejunum. (*B*) Second operation; resection of recurrent ulcer—anterior gastro-enterostomy. Good clinical result three years after second operation.

In conclusion, we wish to exphasize that an x-ray examination of the post-operative stomach is a vital part of a follow-up study; that it gives valuable information as to prognosis, and finally, that it can aid surgery in reducing its number of serious complications.

SOME PROBLEMS AND RESULTS IN CHOLECYSTOGRAPHY[1]

By CASSIE B. ROSE, M.D., *Presbyterian Hospital, Chicago*

CLINICIANS often inquire of the roentgenologist as to the dependability of cholecystography in the diagnosis, and differential diagnosis, of gall-bladder disease, and if it is preferable to give the dye orally or intravenously.

The data of 20 American authors who report statistics concerning their series of cholecystographies, particularly those checked by surgery, are presented in this paper, in addition to the data which I obtained from a study of cholecystographies done in the Presbyterian Hospital, Chicago.

These 20 authors reported a total of 39,280 cases, of which 5,983 came to operation. The figures are incomplete as to the method of giving the dye. From statements in their writings, however, I judge that most of Kirklin's patients were given dye orally, and most of Moore's, intravenously. These are the two largest groups of this series. Others report the dye given 6,729 times orally, and 2,431 times intravenously. It is probable that the dye was given more often orally.

The figures are complete as to the number coming to operation, with the percentage of cases in which the x-ray diagnosis of a pathologic gall bladder was confirmed. The figures are incomplete as to the number of cholecystograms from which diagnoses of normal or pathologic were made. As far as is given, 4,705 were called normal, and 4,813 pathologic.

The largest number of cases is from the Mayo Clinic, in which 3,517 were operated on out of a total of 25,191. Kirklin divides the cases into four groups with respect to the reliability of the x-ray diagnosis:

1. Non-functioning gall bladder, with and without stones, 95 per cent.
2. Poorly functioning gall bladder, with and without stones, 94 per cent.
3. Normally functioning gall bladder, with stones, 100 per cent.
4. Normally functioning gall bladder, without stones, 81.5 per cent.

Averaging the first three figures of his conclusions, we may say that in 96 per cent of the cases the x-ray diagnosis of a pathologic gall bladder was confirmed by operation, an error of only 4 per cent, while the x-ray diagnosis of normal was found to be erroneous in 18.5 per cent.

Similar figures are given by the other authors in confirmation of the x-ray report of pathology. Their percentages range from 86.4 to 100. The average is 93.3 per cent.

Only seven of these 20 authors give the percentage of cases in which the x-ray diagnosis of normal was confirmed surgically. These are Lord, 52.6, King and Martin, 55, Watkins and Mills, 68.2, Kirklin, 81.5, Case, 83.4, Aspray, 93.7, and Beilin and Carlson, 100 per cent. The average of these figures is 76.34 per cent.

Recently I reviewed the records of 1,616 patients of whom cholecystograms, following essentially the Graham-Cole technic, had been done. In our hospital, the dye is given orally or intravenously, according to the desire and judgment of the attending physician, who also administers it.

The patient is given a light evening meal at about 6:00 P.M., and the dye is given about 9:00 P.M. Food is then withheld, although water may be taken, and the patient is sent to the roentgen department at 9 the next morning. Routinely, films are taken at 9 and 12 o'clock, to show the gall bladder filling, then a meal of high fat content is given and a film made at 2 o'clock, to determine the emptying of the gall bladder.

[1]Read before the Radiological Society of North America, at the Eighteenth Annual Meeting at Atlantic City, Nov. 28–Dec. 1, 1932.

Variations in this routine are as follows: If the gall bladder is slow in filling, the fat meal is withheld until after the 2 o'clock film, and a 4 o'clock film is made to determine the emptying. If the gall bladder filled well, but emptied poorly at 2 o'clock, a film is taken at 4 o'clock to determine delayed emptying. In addition, if the gall bladder is obscured by gas or fecal material, the patient is given one or more enemas during the course of the examination, in an attempt to clear the bowel and secure a better visualization of the gall bladder.

Wet films are examined in order to make any needed change in the routine and to secure the best work in each case by the roentgen department. It is very important to get films of good technical quality. which are free from movement. When the gall-bladder examination is complete and the films are dry, the final report is made.

I have already discussed the interpretation of films and will not repeat the matter here (21).

In the series of 1,616 cases reviewed for this report, 1,712 cholecystograms were made, due to re-checks. In 868 of these, or 50.7 per cent, the dye was given orally, and in 844, or 49.3 per cent, the dye was given intravenously. The x-ray findings were reported as normal in 911 examinations, and as pathologic in 801. The x-ray reports were considered to check with clinical findings in 1,386 cases in which 686 intravenous and 700 oral administrations were made; they did not check in 326 cases, 155 intravenous and 171 oral administrations of the dye.

Of these patients 295 were operated upon. In 209, there was a pathologic gall bladder with stones; in 53, a pathologic gall bladder without stones, and in 33, the gall bladder was normal. The x-ray diagnosis failed to check with the surgical diagnosis in only 25 out of the 286 cholecystograms done on the pathologic groups. These 25 cases, 14 oral and 11 intravenous administrations of dye, had been reported on roentgenographically as normal in function. Two gall bladders, although normal in function, were reported to contain stones which were not found at operation.

In the 33 cases in which a normal gall bladder was found at operation, there were 34 cholecystograms, 28 of which checked, six did not check with the operative findings, two oral and four intravenous administrations of dye.

The x-ray diagnosis of a normal gall bladder checked with the surgical findings in 64.7 per cent of the cases; the x-ray diagnosis of a pathologic gall bladder was checked surgically in 96.76 per cent. The x-ray and clinical diagnoses checked in 81.8 per cent.

The greatest number of errors was in diagnosing as normal those cases which, at operation, showed chronic cholecystitis without stones. Several of these cases were reported as "slight chronic cholecystitis." It is well known that a moderate degree of chronic gall-bladder infection need not seriously impair the function of that organ.

Other mistakes in this series operated upon were caused by gas in the bowel. Once a normal gall bladder appeared to fill faintly, twice stones were reported which were not present at operation, and twice stones found by the surgeon had been interpreted roentgenographically as gas in the bowel. On one of these, the report was, "Normally functioning cholecystogram with several gas bubbles partly overlying the gall bladder. Adjacent to them is a smaller round area of decreased density which remains within the gall-bladder outline on all three films. Probably gas, but cannot rule out stone." This shadow shifted position somewhat within the gall bladder. While operating upon this patient for a duodenal ulcer, the surgeon palpated a pea-sized stone in the gall bladder. On reviewing the films, I believe I should have had more courage and reported this shadow as a positive stone. Still it illustrates a common source of difficulty in diagnosis.

In nine cases, carcinoma was found at operation: four times in the head of the pancreas, twice in the gall bladder, once

each in the ampulla of Vater, the stomach, and an ovary. Three of these had metastases to the liver. In the case of carcinoma of the stomach with liver metastases, and in one case of carcinoma of the head of the pancreas, the gall bladder was normal surgically and roentgenographically. In the other seven cases, there was a nonfunctioning gall bladder roentgenographically, which could be accounted for at operation by disease of the gall bladder itself, by compression of its duct, or by extensive liver metastases.

Liver dysfunction was reflected cholecystographically in the case of a male patient, age 23 years, who was suffering from an acute catarrhal jaundice. Three cholecystograms were made, with oral administration of the dye, the second being made after two days, the third, after six days. Upon evidence of the first two, the gall bladder was reported as nonfunctioning; after the third it was reported to be normal. The jaundice had markedly subsided three days before the last cholecystogram.

Cysts of the gall bladder were found twice at operation. In one case, the intravenous cholecystogram showed a "very faint filling," which was explained surgically by a cyst, 1 cm. in diameter, near the gall-bladder neck, which apparently had caused a partial compression. In the other case, a soft round shadow on the plain film corresponded with the position of the *round* gall-bladder outline seen on the cholecystogram made when the contrast medium was given intravenously. There was fairly normal gall-bladder function. It was also noted that the partly emptied gall bladder was smaller than the soft shadow on the plain film. These findings were explained later when a cyst was found in the lower pole of the gall bladder, lined with the same type of mucous membrane as the rest of the gall bladder and connected with it by a small opening the size of a pea. Evidently this cyst had been visualized faintly on the plain film, and had filled and partly emptied during the making of the cholecystogram.

Of interest, because of his youth, is the case of a boy 18 years old, in whom a cholecystogram showed a poorly filled gall bladder with stones. This diagnosis was confirmed surgically a year later.

It is not surprising that duct stones are rarely, if ever, demonstrated as such roentgenographically, or that they either partly or completely prevent the filling of the gall bladder. Two such cases in this series illustrate the value of a close co-operation between the roentgenologist, the clinician, and the surgeon. In both these cases the gall bladder, at operation, seemed normal, and no stones could be palpated in the gall bladder or the ducts. And yet, because the clinician stated that the symptoms were those of an obstructed gall bladder, and because the roentgenologist had reported "no filling," the surgeon probed the duct and found, in each case, a small stone.

In another patient, a man of 60 years, the gall bladder was seen to be nonfunctioning upon administration of dye intravenously. At operation, the gall bladder was found to be of normal size; it was thick and contained several stones. It lay in a dense mass of adhesions, and, as the patient was fat, the duct was difficult to palpate. Because of the patient's condition, it was deemed unwise to attempt further exploration, although, from the symptoms, a duct stone was suspected. A few days later, at the postmortem examination, it was found that the common bile duct was dilated to 2.5 cm. in diameter, and obstructed by a stone in the ampulla.

The following case illustrates how persistently a gall bladder may sometimes retain its normal function, even after recurrent stones and a considerable amount of surgery.

On Sept. 28, 1928, this woman's gall bladder was found in a mass of adhesions. It was very difficult to dissect out and was so adherent to the pancreas that it could not be removed. The atrophied gall bladder was drained and found to contain two large and several small stones. The

TABLE I

Author	Number of Cases	Method of Administration	Cholecystography		Surgical Check		
			Normal	Pathologic	Number Operated On	Normals Checked Correctly	Pathology Checked Correctly
Carman and Counseller (1)	178	Intravenous			39		87 per cent
Zink (2)	663	Oral and Intravenous			131		94.2 per cent
Stewart and Ryan (3)	100	Oral	40	60	23		95 per cent
Whitaker (4)	60	Intravenous			28		93 per cent
King and Martin (5)	407	Oral			62	55 per cent	88 per cent
Chandler and Newell (6)	662	Oral and Intravenous			50		
Aspray (7)	498	Oral and Intravenous	186	312	80	93.7 per cent	100 per cent
Stewart and Illick (8)	600	Oral	273	327	69		97.1 per cent
Oakman (9)	305	Oral	143	162	37		97.3 per cent
Lord (10)	100	Oral and Intravenous	19	81	100	52.6 per cent	86.4 per cent
Lockwood and Skinner (11)	1,500	Oral	890	610	192		96.4 per cent
Watkins and Mills (12)	625	Oral	305	320	100	68.2 per cent	97 per cent
Case (13)	2,000	Intravenous			277	83.4 per cent	90 per cent
Robins and Goldberg (14)	1,014	Oral	502	512	182		85.5 to 87 per cent
Kirklin (15)	25,191	Oral and Intravenous			3,517	81.5 per cent	96 per cent (average)
Moore (16)	3,044	Oral and Intravenous	1,477	1,567	416		98.7 per cent
Hawley (17)	500	Oral and Intravenous	236	242 (22 inconclusive)	146		90 per cent (oral) 91 per cent (intravenous)
Beilin and Carlson (18)	750	Oral			150	100 per cent	98.3 per cent
Fleming (19)	233	Oral and Intravenous			233		88.2 per cent
Littig and Lisk (20)	800	Intravenous	403	397	151		
Rose (21)	1,616	Oral and Intravenous	911	801	295	64.7 per cent	96.7 per cent

ducts could not be palpated, although the symptoms indicated that a common duct stone was present.

On Dec. 10, 1928, the patient was operated upon again. There were adhesions which were easily broken up. The gall bladder was shrunken, and no stones could be palpated in it, or in the cystic duct. A stone the size of a pea could be felt in the common duct, at the ampulla of Vater, but it could not be forced back. The ampulla was then enlarged, and the stone removed from the duct.

On June 24, 1929, an intravenous cholecystogram showed normal function, with two large negative or cholesterol stone shadows within the gall bladder.

On July 24, this patient was operated upon for the third time within 10 months. On exploring, stones could be seen through the gall-bladder wall. At this operation it was possible to free the gall bladder from the liver down to the cystic duct, and to remove it.

The following case history is of interest from the standpoint of the diagnosis of stones by x-ray. It also indicates something of the rapidity of their growth, and how difficult it may be to palpate them at operation.

The clinical history of a woman who was studied in our hospital in May, 1925, suggested gall bladder disease. On the plain films there were four small, round areas of decreased density which were considered to indicate small gallstones. (This was before we had begun to use

cholecystography.) In October, the clinical story was even more suggestive of gallstones. We were then using cholecystography and we, therefore, studied the patient after both oral and intravenous administration of the dye. Roentgenograms showed a normally functioning gall bladder which contained four small, round areas of decreased density, each 4 mm. in diameter. Since these were repeated on all films, the diagnosis was certain. The patient returned home and was operated upon there by the surgeon of her choice, a man of good reputation. He stated that the gall bladder felt entirely normal, and that he could not feel any evidence of stones. He did not open it. While in the hospital, the patient had an attack similar to those noted in the clinical history, though more severe than any previous one. Other lesser attacks followed at infrequent intervals.

In April, 1927, this patient returned to us and the cholecystogram was repeated. The films taken two years after our first study, demonstrated four round areas of decreased density, 1 cm. in diameter, in the dye-filled gall bladder, showing that in the two years the stones had grown to about four times their previous size. She was operated upon within a few days and the gall bladder, containing four stones, was removed.

CONCLUSION

The accuracy of the x-ray diagnosis is slightly better with intravenous than with oral administration of dye. In my opinion, however, this difference is so small that it is entirely fair to give the dye by the oral method first, since it is a more simple procedure and less apt to cause a reaction, including a sore arm. If oral administration is not satisfactory, recheck with the intravenous method.

The x-ray diagnosis of a pathologic gall bladder is dependable up to about 98 per cent. On the other hand, the diagnosis of a normal gall bladder by the x-ray is correct in an average of only 76 per cent of cases, although we have one report of 100 per cent. It is in this "x-ray normal" group that the co-operation between the clinician or surgeon and the roentgenologist is most important.

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PNEUMONOCONIOSIS

WITH SPECIAL REFERENCE TO SOME OF ITS COMPLICATIONS[1]

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PNEUMONOCONIOSIS is a lung disease due to inhalation of minute particles and characterized pathologically by fibroid induration and pigmentation. Although it has been known for many years (Ramazzini, 1703) that dust inhalation incident to certain occupations and trades is accompanied by varying forms of pulmonary fibrosis, still it is only within the last half-century or over, with its enormous industrial development, that pneumonoconiosis has assumed importance as a disabling disease. The different types of pneumonoconiosis vary in relation to the industry: thus, we meet with anthracosis in coal miners, silicosis in rock drillers, asbestosis in asbestos workers, siderosis in gold miners, byssinosis in cotton mill workers, etc. In each of the industries mentioned, these factors, in the order of increasing importance, tend to cause the development of pulmonary fibrosis (pneumonoconiosis).

(1) *Shape.*—The sharp angular particles exert an irritative action on the lungs and are more dangerous potentially, although this is disputed by some authorities.

(2) *Size.*—Small particles below 10 microns, other things being equal, are more hazardous.

(3) *Extent of Exposure.*—The time element requisite for the development of pneumonoconiosis in the dusty trades varies in different industries, in some as low as two years or even less.

(4) *Number of Dust Particles per Cubic Foot of Air.*—It has been estimated that if the number exceeds ten or fifteen millions, the development of pneumonoconiosis is likely; if twenty millions or over, it is almost certain, unless preventive measures are adopted.

(5) *Physio-chemical Properties.*—(*A*) organic dusts; (*B*) inorganic dusts. (*A*) Some authorities are of the opinion that they play no part in the production of pneumonoconiosis, yet pulmonary fibrosis as a result of cotton-mill-dust inhalation is a recognized form of pneumonoconiosis. It is held by most writers that this is due to the admixture of inorganic particles with the organic dust. (*B*) These differ in their potency, as, for example, coal and lime (15) are relatively benign, while silica dust is regarded as the most dangerous. Indeed, the view is held that in all dust inhalation the silica content is the main fibrosing agent.

Heffernan (7) is of the opinion that when the silica dust is deposited in the alveoli of the lungs, it is acted upon by the alkaline fluids and transformed into colloidal silica, which exerts a deleterious action on the pulmonary tissue. He further believes that the pulmonary fibrosis encountered in asbestos workers is due to a transformation of the silicates in asbestos into colloidal silica.

Silicosis according to this hypothesis results from the action of colloidal silica on the pulmonary tissue, and the acuteness or chronicity of the process depends largely upon the silica concentration and the rapidity with which it is transformed into silica sol. Chapman (3) reports three cases of acute silicosis, with autopsy findings in two of them, as a result of comparatively short exposure (about two years) to an alkaline silica mixture in the manufacture of scouring soaps.

As to the mechanism of the process involved in the production of pulmonary fibrosis, the protection offered by the cilia of the upper respiratory tract is broken down under the continuous and

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prolonged inhalation of massive dust doses, so that the dust particles gain entry into the alveoli. The mononuclear phagocytes which are derived from the alveolar walls, and which form the second line of defense (10), endeavor to engulf and destroy the foreign particles the débris of which is drained off through the lymphatics. Under unfavorable circumstances the phagocytes themselves may undergo destruction, the lymphatic structures and subpleural spaces may become clogged with the foreign particles, an attempt at encapsulation may be made by the fibroblasts, and fibrosis initiated. The amount of hyperplasia and induration resulting varies with the character and quantity of dust deposited in the lung tissue and the length of exposure. Gardner (5), in autopsy reports on silicotics, finds that: "The tracheobronchial lymph nodes present even more extensive lesions than are found in the lung. The sinuses are in most places obliterated by reaction to excessive amounts of dust or by healed and calcified tubercles. In other places they are greatly dilated. Around the node is dense fibrous tissue which has caused a dilatation of the afferent lymph vessels." He advances the interesting hypothesis that the primary lesion of silicosis is located in the tracheobronchial lymph nodes and that their partial obstruction by healed foci of infantile tuberculosis has a determining influence on the rapidity with which workmen develop silicosis. Thus, if a workman presents such healed foci, he will develop sufficient connective tissue in a relatively short time to complete the obstruction to the lymph flow and hence the dust, finding no other egress, will accumulate within the lung.

The symptoms and physical signs displayed will vary with the amount of pulmonary fibrosis. On clinical grounds three stages may be described—mild, moderate, and advanced. In the first stage, few or no physical signs are obtained on physical examination. Roentgenologically, however, there is a definite increase in the hilum and trunk shadows and linear markings; the diaphragm (right leaf) may show a slight ascent due to an accompanying pleuritis. The roentgen appearance in this stage may be confused with that of cardiac decompensation, bronchitis (acute or chronic), and asthma, hence the importance of the occupational or medical history. In the second stage there is a history of cough with little or no expectoration, of chest pains, and the following physical signs: dyspnea on exertion, deficient lung expansion, impaired resonance on percussion, diminished breath sounds, with occasional dry râles and friction rubs at the lower bases. The x-ray reveals more or less diffuse mottling through the lung parenchyma owing to deposition of the dust in the lymph spaces. This mottling is usually more prominent at the bases than at the apices and initially more marked on the right side. In the third stage, clinically, there is an accentuation of the signs and symptoms encountered in the second, *viz.*, chest pains, deficient lung expansion. Dyspnea is a prominent symptom in some cases, especially of asbestosis, in which marked loss of weight and facial pallor are noted. Roentgenologically, there is a coalescence of the nodular areas noted in the second stage into opaque shadows simulating consolidations. Cases of asbestosis differ radiologically in the second and third stages in that the fibrosis appears softer and more delicate, the indurative changes being more interstitial. Pulmonary tuberculosis in the second and third stages, especially that of silicosis, is not an infrequent complication.

CASE REPORTS

We present six cases illustrative of different types of pneumonoconiosis in various stages.

Case 1. J. C. D., white male, 39 years of age, married, coal miner for past 13 years, was admitted to the Veterans' Administration Hospital, Memphis, Tenn., on Jan. 11, 1932, for treatment of valvular heart disease with cardiac hypertrophy,

Fig. 1. Shows marked increase in hilum and trunk shadows, with scattered fine mottling in both lungs. *Diagnosis:* Anthracosis, late first stage, or early second (coal miner for 13 years).

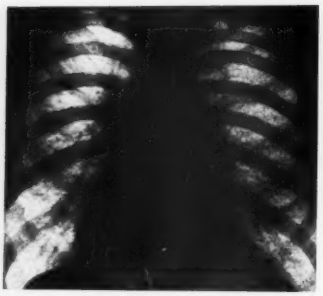

Fig. 2. Shows increase in hilum and trunk shadows, with accentuation of linear markings and fine nodular mottling in both lungs. *Diagnosis:* Pneumonoconiosis-byssinosis. (Patient had been a textile worker for past 12 years.)

Fig. 3. Shows diffuse mottling, especially in upper lobes. This nodular mottling appears soft and shows a tendency to conglomeration; costophrenic angles partially obliterated. *Diagnosis:* Silicoanthracosis, late second stage, or early third. (Coal miner for 30 years; sputum persistently negative for tubercle bacilli, guinea pig negative.)

chronic tonsillitis, and sinusitis. Complaints on admission were shortness of breath and joint pains. Family history was negative. The man gave a personal history of the ordinary diseases of childhood, typhoid fever (1910), malaria, pleurisy (1911). *Physical examination:* Ears, eyes, nose, and throat were negative except for infected tonsils, which were subsequently removed. *Chest:* Expansion good and equal on both sides; few roughened breath sounds (both lungs), with no râles. Temperature, pulse, and respiration, normal. Blood pressure 126/80. Heart examination essentially negative. The remainder of the physical examination was unimportant. *Laboratory reports:* Blood count and blood chemistry within normal limits, Wassermann and urinalysis negative. Roentgenogram of chest showed marked increase in hilum and trunk shadows, with scattered fine mottling in both lungs. *Diagnosis:* Anthracosis, first stage (late) or early second. (See Fig. 1.)

Case 2. C. J. R., white male, age 33, married, occupation textile worker for the past 12 years, was admitted to the Veterans' Adminstration Hospital, Memphis, Tenn., on April 20, 1931, with complaints referable to the nose and eyes. Family history was negative. *Personal history:* Ordinary diseases of childhood; hospitalized for sinus infection while overseas; acute bronchitis (1930). *Physical examination:* Special ear, eye, nose, and throat examination gave a diagnosis of chronic catarrhal otitis media, bilateral, mild; deviated nasal septum. Examination of the chest was essentially negative, except for slight increase and roughening of breath sounds. Temperature, pulse, and respiration were normal; blood pressure, 110/80. Cardiac and remainder of physical examination negative. *Laboratory tests:* Blood count within normal limits; Wassermann and urinalysis negative. Roentgenogram of chest (Fig. 2) showed increase in hilum and trunk shadows, with accentuation of linear markings and fine nodular mottling in both lungs. This case is of interest as illustrating another type of pneumonoconiosis, *viz.*, byssinosis.

Case 3. S. M., white male, age 55, height 5 feet, 8 inches, weight 155 pounds, was admitted to Sea View Hospital, Staten Island, N. Y., complaining of persistent cough, dyspnea on slight exertion, and expectoration. He had been a coal miner for the past thirty years. *Physical examination:* Head and neck negative; chest showed decreased expansion, with impaired resonance on per-

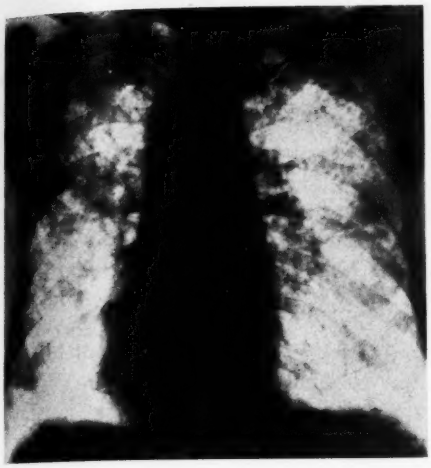

Fig. 4. Shows diffuse mottling, more marked in upper lobes due to coarse dense nodules. Questionable areas of decreased density at upper apices. Pleuritic adhesions at base. *Diagnosis:* Silicosis, second stage, complicated by pulmonary tuberculosis. (Occupation, rock driller for past 12 years; sputum positive for tubercle bacilli.)

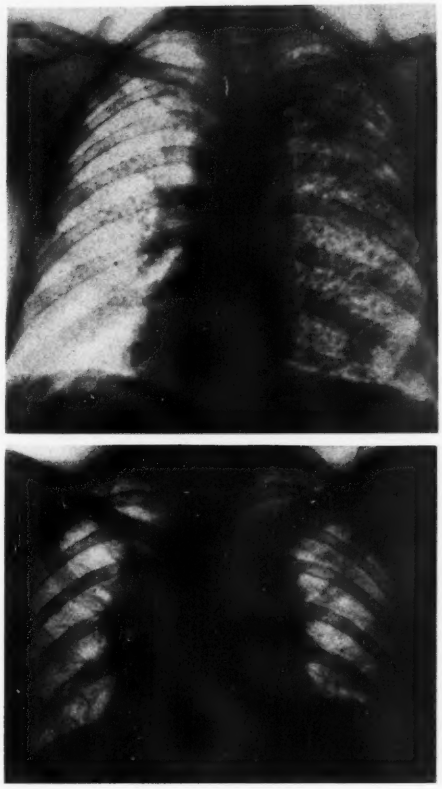

Fig. 5. Shows diffuse mottling from upper apices to lower bases and somewhat more marked on right side. Cavitation in right upper lobe, both costophrenic angles obliterated. *Diagnosis:* Silicosis complicated by pulmonary tuberculosis with cavitation. (Occupation, rock driller for past 20 years; sputum positive for tubercle bacilli; frequent hemoptyses, one rather severe. Pneumothorax on right side unsuccessful on account of adhesions.) (*Above.*)

Fig. 6. Shows marked ascent of both leaflets of the diaphragm with obliteration of right costophrenic angle. Hilar and trunk shadows increased in size and density; haziness of right upper lobe; ground-glass appearance of film. (Data: 22 sputa examinations negative for tubercle bacilli, yeast, or fungi; guinea pig negative for tuberculosis. (Occupation, asbestos worker for 7 years, previously mill operator.) (*Below.*)

cussion from upper apices to lower bases. On auscultation the breath sounds were found to be decreased; a few dry râles were elicited in both infraclavicular regions, with occasional friction rubs at the lower bases. The remainder of the physical examination was essentially negative. Temperature, pulse, and respiration were within normal limits. *Laboratory data:* Blood, urinalysis, and Wassermann tests were negative. The sputum measured about a quarter of a cupful daily, and 20 sputa examinations were negative for tubercle bacilli. Guinea pig injection was negative for tuberculosis; roentgenogram (Fig. 3) shows diffuse mottling from the upper apices to the lower bases, more marked at the central and middle zones. This nodular mottling appears soft and shows a tendency to conglomeration. Costophrenic angles are partially obliterated; heart and aorta are normal; hilum and trunk shadows are accentuated. *Diagnosis:* Pneumonoconiosis: anthracosilicosis, second stage (late) or early third.

In anthracite mining the question of silica, as contributing towards pneumonoconiosis, assumes importance and where the workman has to cut through siliceous layers the subsequent pulmonary changes may be those of silicosis. However, coal dust, is in general regarded as deterrent to the development of silicosis. Case 3 may perhaps serve as an illustration of the

end-result of prolonged exposure to coal dust, which is nearly always pulmonary fibrosis unassociated with tuberculosis. Anthracosis is associated with a high pneumonia rate (63 per cent as contrasted with 35 per cent in cases in which anthracosis is not present, according to White). On the other hand, coal miners in general show a low morbidity from pulmonary tuberculosis, a fact which has been construed as showing that coal dust is chemically antagonistic to the tubercle bacillus, while some think the fibrosis incident to the encapsulation of the coal dust in the lungs is defensive against tuberculosis. In this connection, it is interesting to refer to the experiments of Hennes on the treatment of pulmonary tuberculosis by dust inhalation. Taking the fact that lime or sulphur is rarely associated in industry with pulmonary tuberculosis, he treated tuberculous patients by dust inhalations from four to six times daily for two-minute periods, increasing to six or eight times for from five to eight minutes. He continued the treatment for four months, observed the cases for fifteen months, noting improvement in temperature, sputum, pulse, weight, and roentgen findings. He did not demonstrate silicosis roentgenologically in these cases.

Cases 4 and 5, on account of the essential similarity in symptoms and physical signs as well as roentgen data, and for the sake of brevity, will be considered together. Case 4. P. A., white male, age 43 years, height 5 feet, 8 inches, weight 150 pounds; occupation, rock drilling in subway excavation work for the past 12 years. *Complaint on admission:* shortness of breath, cough, expectoration, occasionally blood-streaked sputum. Family and past histories were negative. *Physical examination:* head and neck were negative. Chest—expansion, deficient; impaired resonance of both upper apices and, to a lesser extent, throughout both lungs; on auscultation, roughened breath sounds, with moist râles, were elicited in both apices and occasional friction rub at lower bases. In the infraclavicular region the breath sounds were somewhat subdued. Case 5. H. J., white male, apparent age 40 years; occupation, rock driller for the past 20 years. *Complaint:* shortness of breath; cough, with expectoration; history of hemoptysis. *Chest examination:* essentially similar to that of Case 4, except that in the right upper lobe there was bronchial breathing with amphoric cough. As shown by Figures 4 and 5, there is a diffuse mottling of the lungs from upper apices to lower bases due to coarse nodules which appear dense and opaque. There is some evidence of pleuritis at the lower bases of both chests; areas of decreased density are noted at the upper apices in Figure 4, and in Figure 5 there is distinct evidence of cavitation of the right upper. *Clinical course:* both patients showed a tendency to evening rise in temperature, sputum frequently blood-streaked and positive for tubercle bacilli. Case 5 had several hemoptyses, one rather severe, which led us to attempt pneumothorax on the right side, an attempt which was, however, unsuccessful on account of adhesions. The coincident tuberculous changes in these two cases of silicosis are in keeping with the high incidence of pulmonary tuberculosis as a complication in silicosis. A. R. Smith, in a study made of 208 rock drillers, blasters, and excavators in New York City, found 57 per cent to be affected with silicosis and 9 per cent of the cases to be complicated by pulmonary tuberculosis. The late G. M. Kober, in an analysis entitled "Occupation in Relation to Tuberculosis," showed that the proportional death rate from tuberculosis among buhrstone dressers (who are constantly exposed to silica dust in the course of their work) is 77.8 per cent as against 5.6 per cent among lumbermen, who presumably have no exposure to dust containing silica.

The next case to be reported is another form of pneumonoconiosis, namely, asbestosis.

Case 6. R. C., white male, aged 42 years, married, and the father of five children living and well. Pre-war occu-

pation, mill operator; enlisted May 3, 1917; discharged Sept. 28, 1922; on sick call many times for shortness of breath; post-war occupation, asbestos-plant operator for the past seven years; admitted to Veterans' Administration Hospital, Memphis, Tenn., Dec. 21, 1931. The family history was unimportant, and the personal history included pneumonia at 15 (previously hospitalized elsewhere for chronic bronchitis, pleuritis, pulmonary tuberculosis far advanced, and pneumonoconiosis). *Chief complaints on admission:* shortness of breath; cough, with some expectoration; loss of weight; easy fatiguability; indigestion.

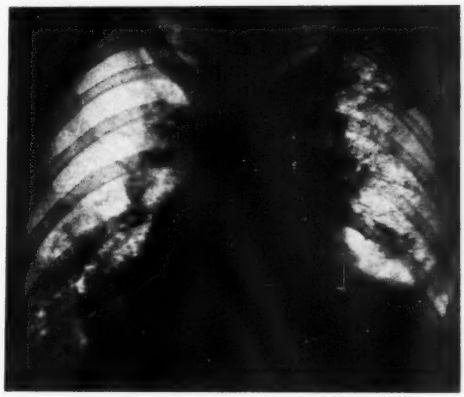

Fig. 7. Film taken after lipiodol injection shows marked deviation of trachea to right and dilated bronchi.

Physical examination disclosed an undernourished white male of asthenic type, 5 feet, 10 inches in height, and weighing 115 pounds. There was marked dyspnea on slight exertion, facial pallor, and mild clubbing of finger nails. Tonsils were embedded and appeared infected; pharynx congested; larynx somewhat reddened; teeth in good condition. Chest was elongated and flattened, with marked decrease in mobility of both lower chest walls, and atrophy of the pectoral muscles, especially on the right side. On palpation there was increased tactile fremitus in the right upper lobe, with diminution at the right and left lower bases. The percussion note was somewhat accentuated in the right infraclavicular region and diminished at the right lower base. The left lung gave impaired resonance from the fourth interspace midaxillary line downward. Auscultation of the right lung revealed whispered fremitus, increased in upper lobe anteriorly and posteriorly; dry râles (which persisted after coughing) in infraclavicular region. The cough was amphoric in character and there was suggestive cavernous breathing in the right infraclavicular space. In the region of the right lower lobe, breath sounds were distinctly diminished. Auscultation of the left lung showed scattered dry râles on coughing, and diminished breath sounds at the lower base. Cardiac sounds were normal. Blood pressure was 115/75; temperature, 98°; pulse, 84; respirations, 20. Sputum was mucoid in character and averaged from one-half to three-fourths of a cup per day. Cough was persistent, especially during the morning hours when most of the sputum was expectorated. The remainder of the physical examination was negative. *Laboratory data:* red blood cells, 4,500,000; white blood cells, 4,600; polymorphonuclears, 54; small mononuclears, 44; eosinophils, 2; hemoglobin, 89 per cent; urinalysis, negative; 22 sputum analyses were negative for tubercle bacilli, yeast, or fungi; injected guinea pig proved negative on autopsy; no asbestosis bodies demonstrated. Electrocardiogram showed normal sinus rhythm, with deepening of S in lead one, and left axis deviation; the P-R interval and Q-R-S, normal; auricular and ventricular rate, 74. Gastric analysis and x-ray examination of intestinal tract, negative. The roentgenogram of the chest on admission showed (Fig. 6) a marked ascent of both leaflets of the diaphragm, with obliteration of the costophrenic angle on the right side and some thickening of the parietal pleura of the right lower lobe. The hilar and trunk shadows increased in size, the linear markings were accentuated. In the region of the right upper lobe a haziness was noted, with radiating strands in the right

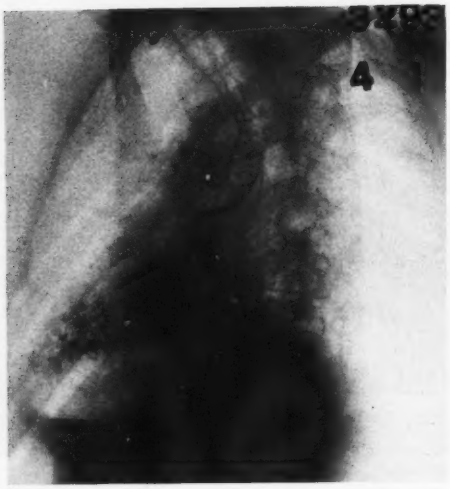

Fig. 8. Oblique position—delineates thickening of parietal pleura of right lung and dilated bronchi. *Diagnosis:* Asbestosis, third stage, complicated by bronchiectasis.

infraclavicular region. On fluoroscopic examination, the diaphragm on deep inspiration descended 1.5 centimeters. Lipiodol injection showed (Figs. 7 and 8) dilatation of the trachea, which was markedly drawn to the right, dilated bronchi in the right upper lobe, while the secondary bronchi in the right and left lower lobes were quite accentuated and appeared dilated. A diagnosis was made of asbestosis, third stage, complicated by bronchiectasis, moderately advanced, with no evidence of pulmonary tuberculosis.

This case on closer clinical analysis differs from the preceding five in the marked shortness of breath, amounting to a distressing dyspnea and, at times, to orthopnea; in the facial pallor, and emaciation. Again, roentgenologically, there is almost an entire absence of the diffuse nodular mottling so characteristic of advanced silicosis. Merewether (11), in an examination of 363 asbestos workers, found 26.2 per cent to be affected with asbestosis, and an additional 5.8 per cent showed precursive signs of this disease. He furthermore found that "they do not produce a picture of silicosis and have not been shown to be associated with an increased mortality from pulmonary tuberculosis." Comparing asbestosis with silicosis in the radiologic and postmortem examinations, this same author notes that the asbestos type of fibrosis is more delicate, softer, and more diffuse. In contra-distinction to the dictum of Riddel that pulmonary fibrosis is brought about by any given dust insofar only as this dust contains silica, and to that of Heffernan's hypothesis (7) that asbestos (a silicate) produces fibrosis by being converted into colloidal silica in the pulmonary tissues, Merewether states that "there is evidence that other inorganic dusts containing no free silica may be productive of this fine type of pulmonary fibrosis in varying degrees." A view not dissimilar to that of Merewether is expressed by Pancoast and Pendergrass (12) when they state: "There is probably more reason now to regard 'silicosis' as an occupational term rather than a synonym for 'penumonoconiosis.'"

In the differential diagnosis of pneumonoconiosis during the early stages, bronchitis (acute and chronic), and cardiac decompensation have to be ruled out; in the later stages, pulmonary tuberculosis as an independent or complicating disease, also mycotic infections and carcinomatosis of the lungs. As an illustration of the difficulty occasionally encountered in arriving at, or excluding, a diagnosis of pneumonoconiosis, it may be pertinent to give another brief case report.

Case 7. W. A., white male, aged 35, height 5 feet, 8 inches, weight 128 pounds, married, one child living; occupation, farmer and coal miner since discharge from the service. At the time of his first admission to the Veterans' Administration Hospital, Memphis, Tenn., Jan. 13, 1932, the chief complaints were: cramping pains in the right side below the costal margin; vomiting of bitter, yellow bile, also a productive cough, especially at night; a soreness of the chest, which was tight and wheezed at night. The patient left hospital the same day against medical advice on account of serious illness at

home, for which reason the examination, perforce, was incomplete. However, there was found tachycardia and generalized tenderness throughout the abdomen; a blood pressure of 118/80; cardiac sounds normal; pulse rate, standing, 122; temperature, 98°; respiration, 20; Wassermann negative; red blood cells, 4,350,000; hemoglobin, 86 per cent; white blood cells, 7,100; polymorphonuclears, 67; small mononuclears, 30; large mononuclears, 2; urinalysis, negative. The patient was readmitted on July 14, 1932, appearing acutely ill, at which time examination showed the following: complexion sallow, apparently jaundiced; right chest bulged somewhat, with marked tenderness at the lower base and dullness from the third rib downward; tenderness and slight rigidity of the upper right abdomen; breath sounds absent on the right side from the third rib downward, exaggerated at the right upper apex, and roughened throughout the left lung; no râles or friction rubs on deep inspiration or coughing; blood pressure, 100/60; pulse rate (sitting), 130; cardiac sounds differentiated—no murmurs elicited; temperature, 99° to 101°; respiration, 20 to 26. The laboratory data were as follows: red blood cells, 3,830,000; hemoglobin, 63 per cent; white blood cells, 6,000; polymorphonuclears, 68; small mononuclears, 26; large mononuclears, 4; eosinophils, 2; urinalysis, negative, Wassermann, negative. *Gastric analysis:* total acidity, 53, free hydrochloric acid, 44. On cholecystography, no outline of the gall bladder was obtained. There was an icteric index of 19.8. The gastro-intestinal series was negative. Twenty consecutive sputum tests were negative for tubercle bacilli. For the x-ray findings of the chest on admission, see Figure 9 and its accompanying legend. We aspirated the right pleural cavity (July 22, 1932), and removed 30 c.c. of straw-colored fluid for bacteriologic examination. On further aspiration, five days later, 90 c.c. of straw-colored fluid was removed, the manometric reading being minus one-half, minus two; 50 c.c. of air given, final reading, minus one-half, plus three. Pleural fluid was negative for tubercle bacilli or other organisms. A guinea pig inoculated with the pleural fluid was negative on autopsy (Sept. 13, 1932). Figure 10, made after aspiration and partial gas replacement, shows no change as compared with the admission film except that several fluid levels are noted at the right lower base, suggestive of encysted effusion. Temperature, pulse, and respiration showed a tendency to subside to normal, the appetite was good, the general condition improved, and subsequent chest films showed no change. The patient left the hospital against medical advice on Aug. 17, 1932. A definite pulmonary diagnosis in this case is rather difficult, but it is, most probably, silicosis complicated by encysted effusion on the right side, plus cholecystitis and secondary anemia.

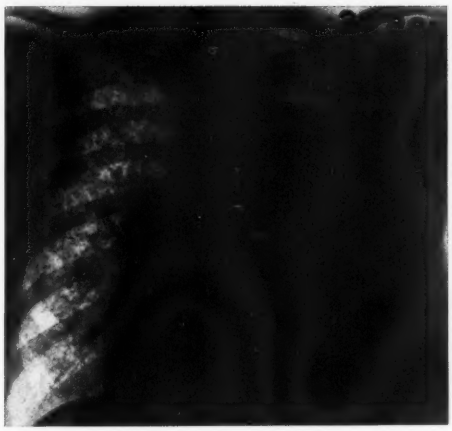

Fig. 9. Shows an opaque shadow of the right lung which extends from the infra-clavicular region downward obliterating lung parenchyma markings and merges inferiorly with right leaf of diaphragm, and medially with the right cardiac border. In the right upper apex mottling is noted. The left lung is mottled throughout by discrete opaque shadows somewhat suggestive of miliary nodulation. The left dome of the diaphragm is well outlined.

While repeated sputum examinations, as well as guinea pig inoculation, are essential, these, as shown above, may be negative, and a diagnosis can be arrived at only by careful consideration of the complete clinical picture. In cases of asbestosis, the

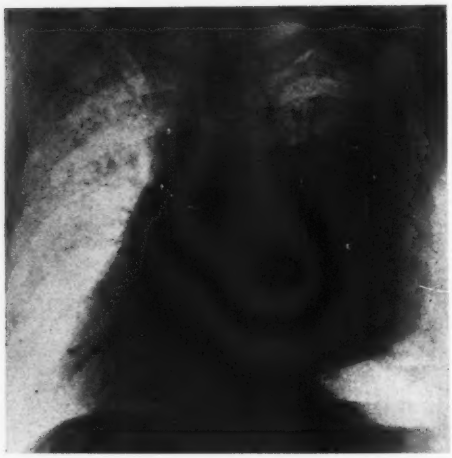

Fig. 10. Subsequent to aspiration and partial gas replacement: shows no change as compared with admission film except that several fluid levels are noted at the right lower base suggestive of encysted effusion. *Probable Diagnosis:* Silico-anthracosis with encysted effusion, right side. (Coal miner and farmer for past 10 years; sputum persistently negative for tubercle bacilli; pleural fluid negative for tubercle bacilli or other organisms; guinea pig negative.)

demonstration of the curious asbestosis bodies is said to be pathognomonic for this disease, although Cooke (4) demonstrated curious bodies similar to those in asbestosis in a case of silico-anthracosis. These asbestos bodies have also been demonstrated in the feces of patients suffering from asbestosis and on biopsy by puncture of the lung. Gloyne (6) cautions that these bodies may be incidental and their presence merely an indication of exposure to asbestos dust. However, in the presence of pulmonary fibrosis and a positive occupational history their occurrence should be considered confirmatory. For differentiation of the various types of pneumonoconiosis the occupational history, clinical signs, and especially the x-ray findings are requisite.

Prognosis varies with the type and stage of pneumonoconiosis; thus Thompson, Brundage, Russell, and Bloomfield (16), investigating the cement industry (calcium dust), found 15 cases of pneumonoconiosis in 53 selected cement workers who were examined clinically and by the x-ray. To quote these investigators: "In none of the cases showing pneumonoconiosis were there any clinical symptoms of the condition, although the general fibrosis present and its distribution through the lungs were indicative of the condition." These writers caution against comparison of the x-ray findings in one dusty trade with those in another in which the offending dust is of a different chemical composition, stating that: "Even when the x-ray films are quite similar in several instances, we cannot be positive that they express the same character of fibrosis or the same degree of physical impairment of the individual." Furthermore, coal miners' lungs (anthracosis), according to Brownlee *et al.*, are consistent with working health although associated with diminished vital capacity, loss of weight, and shortness of breath. Cases of silicosis and asbestosis unassociated with pulmonary tuberculosis give a poor prognosis on account of the progressive nature of the fibrosing process, which may continue even after the workman has changed to a nondusty trade (1), and on account of the liability of circulatory failure incident to hypertrophy of the right heart due to the burden on the pulmonary circulation. In silicosis complicated by pulmonary tuberculosis the prognosis is grave; in asbestosis, only slightly more hopeful. Thus Wood and Gloyne (18), in a study of 57 cases of pulmonary asbestosis, found 10 active cases of tuberculosis, two of them fatal. These workers are of the opinion, however, that obsolescent tuberculosis may remain quiescent in the presence of asbestosis. Silicosis, it is held, lights up any quiescent tuberculous lesions. Gardner's hypothesis (referred to above), if thoroughly confirmed, should militate against employment in the granite industry of individuals who, prior to their entry into this industry, showed roentgenologic evidence of marked calcification of the tracheobronchial lymph nodes.

Treatment of these cases is chiefly preventive in nature. It consists (1) of the adoption of wet drilling methods, in-

stead of dry; (2) the introduction of exhaust devices for the reduction of the dust to a minimum (below 10 million particles per cubic foot), and the use of compressed air respirators, allowing the workman to breathe unpolluted air; (3) a physical and roentgenologic examination prior to entry into these hazardous occupations, with yearly check-up; (4) elimination of the tuberculous or tuberculo-silicotic individual from the mines or industries because of the danger of the spread of the tuberculosis infection. Finally, recognized cases of pneumonoconiosis in the advanced stage, particularly those associated with tuberculosis, need to be hospitalized. Cases of silicosis or asbestosis complicated by pulmonary tuberculosis with cavitation, as illustrated in Case 5, and showing frequent hemoptyses, need rest treatment, and if these symptoms are unallayed, resort may be had to pneumothorax and phrenicotomy. The latter procedure would suggest itself more readily since, in a large percentage of silicosis cases cited by Russell *et al.*, the location of the complicating tuberculous lesion was basal.

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THE TREATMENT OF UTERINE FIBROMYOMAS[1]

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AS is well known, uterine fibromyoma is a very common type of tumor, since 12 per cent of all white women and 30 per cent of all negro women aged approximately 50 years have or have had fibromyomas. In many cases the tumors do not cause symptoms and are found in the course of general examination. Even large tumors which are readily palpated on abdominal examination may not cause trouble and the increase in the size of the abdomen may be the only symptom to attract the patient's attention. Usually, however, the large tumors cause discomfort by pressing on the bladder, or by producing a sense of fullness and weight in the abdomen. Menorrhagia and irregularity of the menstrual cycle, with resulting secondary anemia, are the chief symptoms for which the patient seeks relief. Pelvic pain, although not severe, is present in a large proportion of the cases. In the 320 histories used as a basis for this study, menorrhagia was recorded in 205 (64.05 per cent) of the cases, metrorrhagia in 74 (23.12 per cent), dysmenorrhea in 150 (46.87 per cent), and intermenstrual pelvic pain in 70 (21.87 per cent). Pain occurred in 55 per cent of the cases in which, at the time of operation, the fibromyoma was found to be undergoing degenerative changes.

Earlier writers noted an increase of the conceded normal percentage of infertility among those patients having fibroid tumors of the uterus and the presence of these tumors has been considered to be one of the etiologic factors in sterility. In the series of 320 case histories here reviewed, 268 of the patients were married women, of whom 75 (27.98 per cent) had not been pregnant, and 9 per cent had had miscarriages only. The normal percentage of sterile marriages is considered to be about 10 to 15.

The evolution of treatment of uterine fibromyoma is an interesting chapter in medical history. Vaginal hysterectomy was performed for an extruding organ as early as 1507, when Berengarius, of Bologna, performed the first recorded partial vaginal hysterectomy. In 1600, Schenk, of Grobenburg, reviewed and reported 36 cases in which vaginal hysterectomy was performed, but the operations were done for removal of a prolapsed uterus or for carcinoma of the uterus. The earlier writers did not believe that any fibroid tumor, except a polypus, could be removed. In 1825 John Lizars, and some time before 1831 Nathan Smith, opened the abdomen for what was thought to be an ovarian tumor, but they abandoned the operation when the tumor was found to be a fibromyoma. In 1842 Amussat reported two cases in which vaginal myomectomy was performed for submucous fibromyoma, an earlier operation having been done by him in 1840, which is the first record of a deliberate attempt to remove a uterine tumor. Atlee performed the first successful abdominal myomectomy in 1844, and Kimball in 1853, the first abdominal myomectomy with deliberate intention, the diagnosis having been made previous to operation. Clay is thought to have performed the first abdominal hysteromyomectomy in 1843, the diagnosis being ovarian tumor. Three years later, in the year 1846, Bellinger performed a deliberate hysteromyomectomy for a fibroid tumor of the uterus. The patient died five days later of peritonitis. Burnam, of Lowell, Massachusetts, in 1853 performed the first successful abdominal hysteromyomectomy. Koeberle, of Strassburg, in 1861, performed the first successful hysteromyomectomy in Europe; the diagnosis

[1] Read before the American Congress of Radiology, at Chicago, Sept. 25–30, 1933.

having been made previously and the operation undertaken deliberately. Bordenheuer was the pioneer in developing panhysterectomy in Germany, and Mary Dixon Jones, unacquainted with Bordenheuer's work, at about the same time (1888) performed the first total abdominal hysteromyomectomy in America. Batley, of Atlanta, Georgia, in 1857, suggested removal of the ovaries for non-ovarian conditions. Tait excised the uterine appendages to arrest the growth of a bleeding myoma in 1872, and Trenholm adopted this procedure two years later, although he had performed his first hysterectomy in 1873. From 1880 removal of the uterus through an abdominal incision was a well recognized procedure. It was more than twenty years later that any other means of treating fibromyoma of the uterus was available.

In 1896 the roentgen rays were used therapeutically for cutaneous lesions, and Senn, in 1902 and 1903, reported the use of roentgen rays in the treatment of leukemia. Perthes introduced deep therapy in 1903, and Holzknecht and Kienböck established the scientific dosage in 1900 and 1902. In 1904, Foveau de Courmelles began treating uterine fibromyoma by roentgen rays, publishing later the results of this treatment in 53 cases. The technic was later perfected by Holzknecht, Witterer, Albers-Schönberg, Garl, and Fraenkel and others, and now roentgen rays are frequently used in the treatment of uterine fibromyoma.

In 1905 Abbe reported the first case of uterine fibromyoma in which radium was used in treatment. Later Kelly became one of the foremost sponsors for the use of radium in the treatment of uterine fibromyomas, and Clarke, Burnam, and others were the next pioneers in establishing radium as a definite therapeutic agent in the treatment of uterine fibromyoma in carefully selected cases. We have now at our disposal myomectomy, hysterectomy, radium, and roentgen rays for the treatment of uterine fibromyoma in cases in which the tumor is producing symptoms and interference seems indicated.

Bland-Sutton cited the indications for treatment of uterine fibromyoma in an article written on this subject thirty years ago, and they still remain much the same: (1) when the fibroid tumor causes profuse and long-continued menorrhagia; (2) when it is septic or gangrenous; (3) when it is impacted and irreducible and causes pain or retention of urine; (4) when it is growing rapidly or degenerating, softened and diffluent; (5) when a fibroid tumor of the cervix is too large to permit of enucleation through the vagina, and (6) when it complicates pregnancy, delivery, and the puerperium in certain circumstances. Bland-Sutton wrote of opening the uterine cavity and extracting the tumor and then suturing the incision; to this operation he applied the term "hysterotomy."

The choice of the type of treatment best suited to the individual case depends on several factors: (1) the age and general health of the patient; (2) the size of the tumor and whether it is increasing in size or undergoing degenerative changes; (3) a history of previous pelvic inflammatory disease, or lack of such a history, and (4) the patient's preference. In a small group of cases any one of the types of treatment mentioned may be used with equally good results, and in these cases the patient's preference may be considered. Some patients have a prejudice against the use of radium and roentgen rays; some prefer the treatment which will give greatest assurance of permanent and complete relief of symptoms, whatever the sacrifice of tissue; some are fearful of all operations. Certain patients wish the uterus preserved and the menstrual function disturbed as little as possible, even though they fully understand that more radical treatment may be necessary at some later time.

There are generally accepted rules governing the selection of the form of treatment in certain cases. Abdominal myomectomy is more conservative than radium or roentgen rays for the woman in the child-bearing period. Hysterectomy is

preferable if the tumor is large, if it is increasing in size rather rapidly, if it is producing symptoms indicative of complications such as degeneration or torsion of the pedicle, or if curettage discloses evidence of submucous fibromyoma. The effect of radium and roentgen rays is not immediate and if there is profuse menstruation and marked secondary anemia, transfusion, and then hysterectomy, is often a preferable procedure. Total abdominal hysterectomy is indicated if a badly lacerated or infected cervix is associated with the fibromyoma. In cases in which there is evidence of pelvic infection or a history of previous infection, radium is definitely contra-indicated. Treatment by roentgen rays is thought by many to be a safe procedure in cases of chronic pelvic infection, but as a rule hysterectomy would seem to be safer. Hysterectomy is indicated if there is a possibility of malignancy of the body of the uterus. Radium offers a simple and effective means of treatment for the patient aged more than 37 years, if the fibromyoma has increased the size of the uterus approximately to that of a uterus after four months of gestation, or if the uterus is small and fibrous and the patient has menorrhagia, provided, always, that there is no history and no local evidence of pelvic infection. Treatment by roentgen rays is most useful in reducing the size of the tumor and causing cessation of menstruation in cases of large uterine tumor, when there is a definite contra-indication to surgical operation, such as is presented by obesity, hypertension, cardiac lesion, and nephritis. It also controls the bleeding in cases of a fibrous uterus with menorrhagia. Curettage for diagnosis should precede the use of radium and roentgen rays unless the procedure is thought to be unwise because of the patient's general condition. I believe that in a large percentage of cases in which results are unsatisfactory following the use of radium and roentgen rays, the lesions are submucous fibroid tumors.

PRESENT INVESTIGATION

A comparison has been made of the results of treatment by myomectomy, by hysterectomy, by radium, and by roentgen rays. As has been stated, 320 patients are included in the present study, 80 of whom were subjected to myomectomy, 80 to hysterectomy, 80 to treatment by radium, and 80 to treatment by roentgen rays.

Myomectomy.—Of the 80 patients who underwent abdominal myomectomy, 73 (91.25 per cent) were aged under 40 years. Thirty-five patients (43.75 per cent) had menorrhagia; 10 (12.50 per cent) had metrorrhagia; 47 (58.75 per cent) complained of dysmenorrhea, and 24 (30 per cent) had intermenstrual pelvic pain. Fifty-seven patients were married, 30 (52.63 per cent) of whom had not been pregnant, and 10 (17.54 per cent) of whom had had miscarriages only.

Myomectomy was selected as the type of treatment indicated in this series of 80 cases, for the following reasons: (1) because of the patient's youth in 57 cases (71.25 per cent); (2) because of the presence of a single tumor in 27 cases (33.75 per cent), and (3) because 18 (22.50 per cent) of the patients definitely desired children. Seven women were pregnant at the time of operation—one of these miscarried on the fourth day after operation. Thirty-one of the 80 patients (38.75 per cent) had single tumors; 18 (22.50 per cent) of the tumors showed degenerative changes. There were no deaths following myomectomy.

Replies to questionnaires have been received concerning 62 of the 80 patients who underwent abdominal myomectomy. Two patients had died. The cause of death was not given in one case, and in the other, malignancy of the pelvic organs was reported. This patient had undergone curettage for diagnosis preceding the application of radium. Following operation the menstrual periods of 43 of the 60 living patients (71.66 per cent) became regular and normal; of four (6.66 per cent)

they became regular but profuse, and of eight (13.33 per cent) the periods became irregular. Menopause occurred several years after operation in two cases. The general health of 46 of the 60 living patients (76.66 per cent) was reported to be good, and that of 14 (23.33 per cent) to be fair. Nine of the living patients (15 per cent) reported that tumors had formed subsequently, for which one patient had received treatment by roentgen rays, one by radium, and seven by surgical operation. Three of those who underwent surgical operation had the uterus removed from five to seven years after myomectomy; one had a chemical hysterectomy two years after myomectomy; one had a curettement and treatment by roentgen rays five years after myomectomy; one had curettement with removal of a small tumor three and a half years after myomectomy, and one had curettement nine months after myomectomy. Of the 55 women who had not ceased menstruating, 13 (23.63 per cent) became pregnant after the operation; some had more than one child, giving a total of 22 children.

Hysterectomy.—Of the 80 patients who underwent abdominal hysterectomy, 68 (85 per cent) were aged forty years or more. Menorrhagia was one of the chief complaints of 59 patients (73.75 per cent), and 23 (28.75 per cent) of the 80 patients had secondary anemia; five had undergone myomectomy elsewhere before they came to the clinic, and five had had radium treatment elsewhere without control of symptoms. Indications for operation in this group were as follows: the presence of a large tumor in 62 (77.50 per cent) of the cases; the possibility of an ovarian tumor being present in 10 (12.50 per cent) of the cases, and a history suggestive of malignancy in eight (10 per cent) of the cases. There was a history of previous pelvic infection in nine (11.25 per cent) of the cases and the cervix was badly diseased in 20 (25 per cent). At the time of operation, multiple fibroid tumors were found in 74 (92.50 per cent) of the cases, associated with salpingitis in 57 cases, and with bilateral oophoritis in 37 cases. One patient died in hospital four days after operation, from general peritonitis, giving a mortality rate attributable to the operation of 1.25 per cent. Five patients died subsequently, one of pneumonia six years later, three of unknown cause, and one following an operation for obstruction of the bowel, performed elsewhere, almost three years after the hysterectomy.

The condition of 67 patients who underwent abdominal hysterectomy has been ascertained. Five had died, as has been said, and of the remaining 62, 44 (70.96 per cent) have reported that they are in general good health; 17 (27.41 per cent) that they are in fair health, and one (1.61 per cent) that she is in poor health. Thirty-one patients of the 62 (50 per cent) stated that they were more nervous following operation than previous to operation. Thirteen of the 62 patients (20.96 per cent) stated that they had not experienced hot flashes since the operation, whereas 40 (64.51 per cent) had experienced them. Forty-seven patients (75.80 per cent) reported that there had been no pelvic discomfort following the operation, whereas seven (11.29 per cent) had experienced some pelvic pain. Forty-three patients (69.35 per cent) had gained weight. None of these patients had undergone subsequent operations.

Radium.—Of the 80 patients treated with radium, 10 (12.50 per cent) were between thirty and forty years of age; one was aged less than thirty years; 69 patients (86.25 per cent) were aged forty years or more. In this group of 80 patients, 71 (88.75 per cent) complained of menorrhagia; 33 (41.25 per cent) of metrorrhagia. Surgical operation was considered inadvisable because of hypertension in six cases (7.50 per cent); because of obesity in six; because of previous phlebitis in one; because of carcinoma elsewhere in the body in two, and because of extreme nervousness in four. Two patients had syphilitic aortitis, one had renal calculi, and one was paralyzed. Preliminary dilatation and curettage was done in 49 (61.25 per cent) of the cases. Nine

patients (11.25 per cent) received less than 1,000 mg.-hrs. of radium; 56 (70 per cent) between 1,000 and 2,000 mg.-hrs.; 15 (18.75 per cent) 2,000 mg.-hrs. or more.

Of the 73 patients traced, who received treatment by radium, 68 (93.15 per cent) were living, whereas five (6.84 per cent) had died subsequent to the treatment (two of these had carcinoma elsewhere in the body at the time of treatment; two died from "stroke," and one of unknown cause). Of the 68 living patients, 56 (82.35 per cent) reported their general health to be good; eight (11.76 per cent) stated that their general health was not improved, and seven patients (10.29 per cent) reported the presence of pelvic pain since the treatment. Fifty-seven (83.82 per cent) of the 68 patients ceased menstruating following treatment, and seven (10.29 per cent) did not cease menstruating. One patient had ceased menstruating before the application of radium, and three patients did not mention the menstrual history. Of the seven patients who did not cease to menstruate, one, aged 35 years, received 600 mg.-hrs. and the menstrual flow became normal in quantity but the periods were not regular. One patient, aged 25 years, received 150 mg.-hrs. of radium, and the periods became regular and normal. Another patient, aged 42 years, was given 1,200 mg.-hrs. of radium, whereupon she ceased to menstruate for seven months and then had a return of periods for a time. However, she had not menstruated for two years at the time of her reply. Another woman, 37 years of age, was given 1,000 mg.-hrs., and stopped menstruating for six months; then menstruation became normal for a while but at the time of the reply occurred only occasionally. One patient subsequently was given treatment by roentgen rays and operation was done subsequently on five patients.

Of these five patients, one, aged 45 years, received 1,000 mg.-hrs. of radium and underwent hysterectomy four years later because of profuse and irregular menstruation. A second patient, aged 33 years, received 1,000 mg.-hrs., and was operated on two months later for drainage of a pelvic abscess, and three months after that, left oophorectomy was performed for an abscess. A third patient, six years after treatment, had an intra-uterine and cervical polyp removed for slight vaginal bleeding, and a fourth underwent hysterectomy two years later, for diffuse adenomyoma with necrosis and a hemorrhagic cystadenoma of the ovary. A fifth patient underwent curettement for diagnosis a year and a half after treatment with radium because of a slight vaginal discharge.

Of the 68 patients who were living, 50 (73.52 per cent) reported the presence of hot flashes, and 32 (47.05 per cent) reported increase in nervousness following the treatment, whereas 29 (42.64 per cent) definitely stated that increased nervousness had not been noted. Forty-four (64.70 per cent) had gained weight, and 41 (60.29 per cent) had gained strength.

Roentgen Rays.—Of the 80 patients who received treatment by roentgen rays, 12 (15 per cent) were aged less than forty years, 39 (48.75 per cent) were between forty and forty-nine years, 29 (36.25 per cent) were fifty years or more, one patient was aged seventy-six years, and 11 patients (13.75 per cent) had passed the menopause. Three patients had been operated on elsewhere for a tumor of the uterus, and 18 (22.50 per cent) had undergone other pelvic operations. Forty (50 per cent) complained of menorrhagia; 12 (15 per cent) complained of metrorrhagia, and 13 (16.25 per cent) had pain between menstrual periods. Surgical procedures were contra-indicated in four cases in this group because of malignancy elsewhere in the body; it was contra-indicated in one case because of phlebitis, in one because of hyperthyroidism, and in one because of malignant hypertension.

Information has been received concerning 63 of the patients who were treated by roentgen rays for fibromyomas. Of the 13 who are dead, the cause of death of five is not known, one died of submaxillary abscess and cerebral hemorrhage,

TABLE I.—RESULTS

State of health after treatment and incidence of secondary treatment	Treatment			
	Myomectomy, percentage of 60 living	Hysterectomy, percentage of 62 living	Radium, percentage of 68 living	Roentgen rays, percentage of 50 living
Good	76.66	70.96	82.35	90.0
Fair	23.33	27.41		
Not improved		1.61	11.76	10.0
Menstruation ceased		100.00	83.82	78.0
Menstruation became normal	71.66 (profuse 6.66)		2.93	5.12
Hot flashes		64.51	73.53	62.0
Nervousness		50.00	47.05	30.0
Pain in the pelvis		11.29	10.29	20.0
Subsequent operation necessary	11.66		7.35	4.0
Subsequent roentgen-ray treatment	1.66		1.47	2.0
Subsequent radium treatment	1.66			2.0

one of chronic endocarditis and mitral stenosis, one of nephritis and "heart trouble," one of diabetes, one of arsenic poisoning, one of carcinoma of the breast, and two of "gradual decline"—one of these in coma. Of the 50 patients who were still living at the time of the inquiry, 45 (90 per cent) reported their general health to be good, and five (10 per cent) reported that it was not improved. Thirty-one patients (62 per cent) reported the presence of hot flashes. Ten patients (20 per cent) reported that there had been pelvic pain and 15 patients (30 per cent) reported increased nervousness. Of the 39 who ceased to menstruate, 23 (58.97 per cent) ceased immediately following treatment, 11 (28.20 per cent) in from one to six months after treatment, and the time of cessation was not stated in five cases (12.82 per cent). Menstruation was resumed in two cases, and in three the menstrual history subsequent to the treatment was not mentioned. In two cases roentgen-ray treatment, and radium and curettement, and radium, respectively, were applied. In three cases operation was performed subsequently. Hysterectomy had been performed on one patient one and a half years later—there had been no symptoms in this case, but on examination the tumor was found to be soft and had not decreased in size. One patient was operated on elsewhere, the nature of the operation not being known. One patient had a tumor of the left groin, reported to be a carcinoma of the hypernephroma type twelve years after roentgen-ray treatment; the pelvic examination at the time of operation had been negative. One patient, who had ceased menstruating before treatment, stated that the tumor was enlarged and she felt that operation should be done. Sixty-eight (85 per cent) of the 80 patients had been given one course of roentgen-ray treatment, a course consisting of two or three exposures to the abdomen and to the back, depending on the size of the tumor and the weight of the patient.

SUMMARY

Patients having small fibromyomas which do not cause symptoms should be examined semi-yearly to detect any change in size or consistence of the tumor, and must be warned regarding the importance of any change in the menstrual cycle.

The choice of treatment in cases of uterine fibromyomas that produce symptoms depends on the age and general condition of the patient, the size of the tumor, and symptoms.

Myomectomy is the most conservative treatment. A woman who is in the childbearing period of life should be allowed to choose this form of treatment, pro-

vided it is made clear to her that a radical operation may be necessary later.

Hysterectomy is indicated in cases of previous pelvic infection, in cases in which the history suggests complications, as degeneration of the tumor or the presence of a submucous fibroid.

Roentgen-ray and radium treatment in carefully selected cases give excellent results in a high percentage of cases.

THE BEHAVIOR OF THE INTERVERTEBRAL DISC IN CERTAIN SPINE LESIONS[1]

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AS an involvement of the intervertebral disc often occurs in spinal lesions, a brief review of some of the compiled data concerning its function, anatomy, and vascularization may be conveniently interpolated here.

The intervertebral disc consists of the nucleus pulposus and annulus fibrosus. The soft mass of the nucleus is usually eccentrically situated and is surmised to be the remnant of the chorda tissue of the embryonic spine. It consists of a mass of watery fibrous strands arranged in numerous wavy bundles among which spindle-shaped connective tissue cartilage cells and chorda rests are scattered. Some of these bundles terminate in villous processes. There is a small antrum, first described by Luschka, in the mid-portion of the nucleus, which contains a synovial fluid-like substance. The antrum is multilocular and consists of small gaps between the fibrils.

The fibrous ring consists of a system of lamellæ composed of fibrocartilage. These fibers are coarser than those of the nucleus; they sweep around the nucleus and form a definite capsule for it. Above and below, the lamellæ of the fibrous ring strongly attach themselves to the cartilage plates, which consist of layers of hyaline cartilage, that fit into the uneven grooved surface of the upper and lower bone plate of the vertebral body.

Schmorl (29) in some of his earlier publications stated that the discs did not contain blood vessels. However, Boehmig's (5), Uebermuth's (36), and Smith's (35) investigations showed that there were many nutritive spaces in the nucleus pulposus and annulus fibrosus up to the end of the growing period, and this fact was later confirmed by Schmorl (30) also.

At the end of the growing period these blood vessels start to obliterate, which obliteration is subject to individual variations, as it occurs sooner in some individuals and later in others, somewhere between the ages of 22 and 30. The obliterated blood vessels, according to Boehmig (6), are replaced by a cartilaginous substance which takes up the form of the previous blood vessels and its ramifications can be easily recognized. They are called "blood vessel scars" and are supposed to play an important rôle in the development of some of the cartilage nodes (Schmorl's *Knorpelknoetchen*).

As the blood vessels obliterate, the nourishing material of the disc is received from the vertebral bodies through diffusion. Schmorl (30) demonstrated that the upper and lower surfaces of the vertebral body resemble a sieve. The cartilage plate is firmly attached to this sieved surface, so that the nourishing fluid has to pass through it on its way to the disc, and *vice versa*. As the cartilage becomes older this diffusion undergoes a certain degree of degeneration, this being the reason why an elastic and well maintained disc is so seldom found in older individuals.

The general consensus of opinion is that the mode of infection in spinal lesions is by the hemotogenous route, the lesion being a metastatic process from some primary focus. However, there are some who believe that the lymphatic system is the route by which infection takes place.

The discs form approximately one-fourth of the total length of the vertebral column and vary in vertical thickness in several regions, being thickest in the lumbar and thinnest in the upper thoracic region. Ja-

[1] Read before the Radiological Society of North America at the Eighteenth Annual Meeting, at Atlantic City, Nov. 28–Dec. 1, 1932.

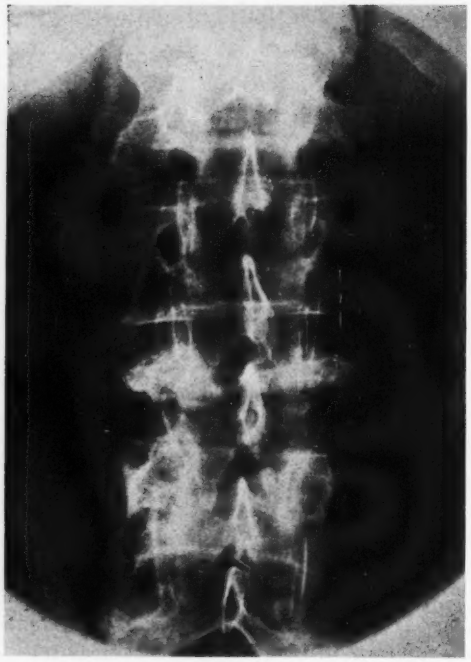

Fig. 1. Tuberculous spondylitis with a completely collapsed third lumbar vertebral body and well maintained intervertebral spaces, giving the appearance of a metastatic tumor.

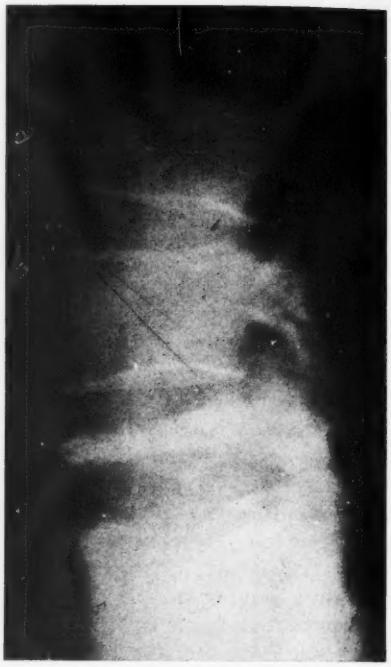

Fig. 2. Tuberculous spondylitis showing the collapsed and flattened third lumbar vertebral body and increased width of the disc above and below.

cobi (15), examining the vertebræ of 102 persons between the ages of 18 and 87, found the smallest values for the disc in the upper thoracic region. He found the proportion of the discs to the vertebral bodies approximately 1 : 1.5 in the thoracic, 1 : 3 in the lumbar region.

The individual discs also show differences in width, mainly between the anterior and posterior portions, which differences are most marked in the lumbar region. The fifth intervertebral disc is often wedge-shaped, influencing the lumbosacral angle.

The function of the disc does not depend on its arrangement as a joint, but upon the physical differences between its constituents and the formation of fibers of the annulus. The nucleus is highly compressible and elastic, the annulus relatively inelastic. The discs thus form delicate buffers between the vertebræ, absorbing shocks transmitted through the spine. Consequently they are rudimentary diathroidal joints, allowing a small degree of movement in all directions, and are important in imparting flexibility to the spine.

The question whether the intervertebral disc can be the primary seat of a disease or whether its involvement is always secondary to an involvement of the bone is also much debated. Schmorl thinks that a primary disease of the disc is possible only in young adults, as they possess a vascularized disc. In grown-ups the disc may be primarily involved only in cases in which, through tears of the hyalin plate, blood vessels enter the disc; or in which, on the basis of a cartilage node formation, vascularization has occurred. He observed a case in which a secondarily vascularized second lumbar disc was the seat of a small abscess in a patient suffering from pyemia subsequent to a Vincent's angina.

Primary metastatic tumors in the disc never have been observed by Schmorl (30), but he saw metastatic tumors extend into the disc from the involved vertebral body. The disc may show narrowing on the roentgen film in cases in which, after destruction of the end plate by metastatic tumors, some of the disc tissue herniates itself into the vertebral body.

Fig. 3. Tuberculous spondylitis. Anteroposterior postmortem film showing some bone destruction and considerable amount of new bone production along the left borders of the first, second, and third lumbar vertebræ.

As slight pathologic processes of the disc—most satisfactorily seen in the lateral view—can be easier visualized roentgenologically than early involvements of the vertebral bodies, we routinely examine its width and contour carefully, as its behavior may betray an existing vertebral lesion not of sufficient size to cast a defi-

Fig. 4. Postmortem lateral view of the same case as shown in Figure 3, showing the vertebral end-plates to be smooth and the intervertebral spaces to be of normal width. The bone destructive process is situated along the anterior borders of the vertebral bodies.

nite shadow. Adib Chasin (8), in an instructive experiment, demonstrated that in the formation of a roentgenogram the compact layer of the vertebral body has the greatest importance. If the entire spongiosa is removed and the defect caused by the removal is filled with paraffin, which is of the density of the neighboring soft tissues, no defects can be recognized on the roentgenograms of the specimen; but even defects of the compact substance cannot be recognized if they measure only

0.5 sq. cm. in size and from two to three mm. in depth. Cylindrical defects which measure 1 cm. in diameter and traverse all the layers of the vertebral body can

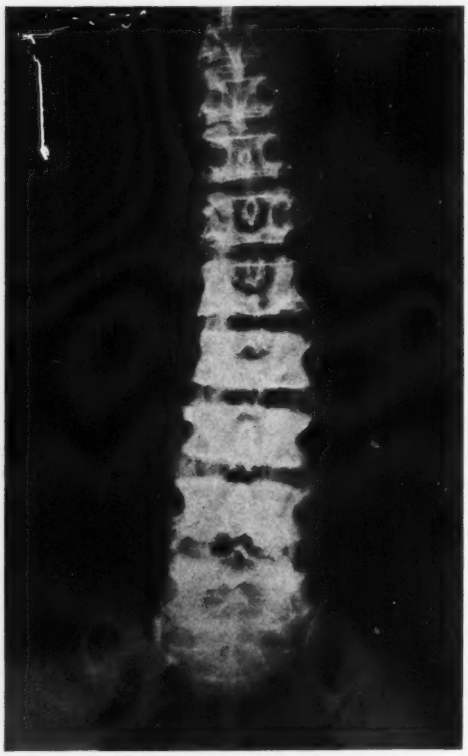

Fig. 5. Tuberculous spondylitis. Anteroposterior postmortem film showing larger spurs along the left borders of the lumbar vertebral bodies and a few small ones along their right borders. The intervertebral spaces appear to be well maintained and the appearance is of a deforming spondylosis rather than of a tuberculous process.

be recognized only in those projections in which the axis of the defect is parallel to the axis of the central ray. Consequently the vertebral lesion has to be quite large to be recognizable.

The question is, that if change in the width of the intervertebral space is an index of a vertebral lesion, can this change be evaluated in the differential diagnosis of the great variety of spinal diseases?

The text-books and many publications consider the narrowing of the intervertebral disc as a good sign for tuberculosis, as against a localized metastatic tumor, in which case the disc is supposed to be found intact. Sicard (32) and his co-

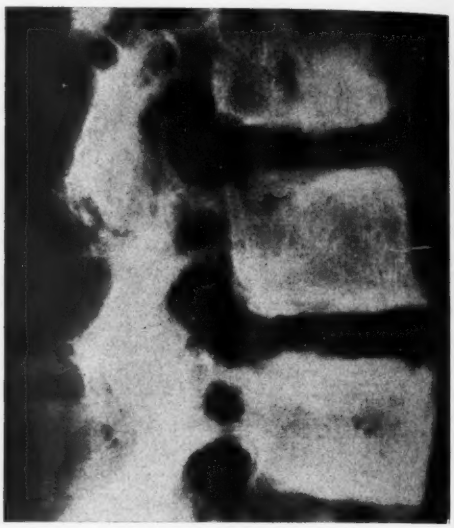

Fig. 6. Lateral view of the same case as shown in Figure 5. A removed section of the lumbar vertebræ showing that, despite a complete destruction of the disc, the intervertebral spaces appear to be well maintained. The destruction of the disc could not be visualized on the premortem films. Note the diffuse osteitis of the vertebral bodies and arches.

workers make the definite statement that metastatic tumors represent a purely osseous disease and the discs are well maintained even in an advanced stage of the disease. On the other hand, Sgalitzer (31) emphasized the narrowing of the disc in all of his cases, as an important diagnostic sign for tuberculous spondylitis. Doub (9), in recent publications, also considers the narrowing of the disc as an important finding in the diagnosis of tuberculous spondylitis.

Baetjer and Waters (3) emphasize that in tuberculous spondylitis there is an obliteration of the joint space, with involvement of the body and with no evidence of new bone production, whereas in non-tuberculous cases there is new bone production and no obliteration of the joint spaces.

Rostock (28), examining 364 cases of

tuberculous spondylitides and vertebral fractures, arrived at the conclusion that the outlines of the intervertebral space are irregular and moth-eaten in every case of vertebral tuberculosis.

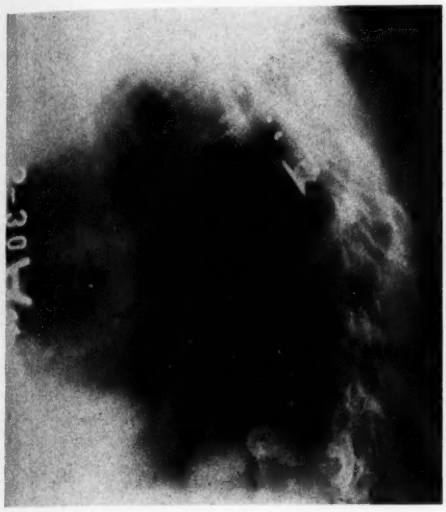

Fig. 7. Metastatic tumors of the sixth and seventh dorsal vertebræ, with marked destruction of the neighboring surfaces of the vertebral bodies and disappearance of the intervertebral space. Note stoppage of lipiodol in the subdural space at the site of the lesion.

Only in the most recent years has opinion begun to be voiced that although these facts are true in the great majority of instances, in case of doubt the behavior of the disc cannot be used as a diagnostic sign, because it may be narrowed in metastatic tumors and well maintained in tuberculosis.

In order to clarify our conception of the rôle of the disc, a large number of spine roentgenograms were reviewed, and the reviewed material contained some answers to the above questions.

TUBERCULOUS SPONDYLITIS

The typical roentgenologic appearance of the tuberculous spondylitis, with destruction of parts of the vertebral bodies, narrowing of the intervertebral space, relatively little or no new bone production, bone atrophy, changes of the physiologic curve of the involved area, and paravertebral abscess formation are well known.

However, there are cases of spinal tuberculosis in which the intervertebral space

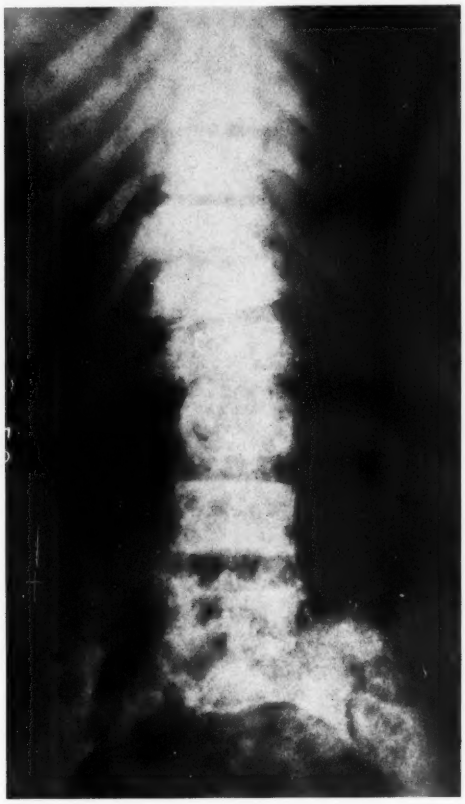

Fig. 8. Metastases to the ribs, vertebræ, and pelvic bones from a carcinoma of the breast. Note the marked narrowing of the intervertebral discs between the eighth and ninth, ninth and tenth dorsal vertebræ, between the twelfth dorsal and first lumbar, between the first and second, second and third, lumbar vertebræ, due to herniation of the discs.

appears to be well maintained on the roentgenogram, despite an advanced bony lesion. Ellmer (11) in his material found similar occurrences. Freund (13) mentions the fact that at times, despite the collapse of two neighboring vertebræ, the disc may remain wide—in one of his cases it was even wider than the neighboring vertebræ. A tumor was first suspected in this case, but the patient also had a

paravertebral abscess, which was tapped. According to the author, such wide gaps between destroyed vertebræ can be understood only in cases in which the patient is bedridden and has a marked rigidity of the back muscles. Besides, the disc must be filled with some material, most commonly granulation tissue. In his case a sequestrum was seen in the intervertebral space.

Fig. 9. Early typhoid spondylitis showing a slight left scoliosis in the anteroposterior view.

Another explanation may be that the paravertebral abscess exerts such a high pressure that it keeps the neighboring vertebral bodies apart. There are no manometric measurements of such abscesses, but occasionally during tapping one sees the pus evacuating under high pressure.

Figures 1 and 2 represent the roentgenograms of a tuberculous spondylitis simulating the appearance of a localized metastatic tumor. The third lumbar vertebral body is completely collapsed by a bone destructive process, measuring about one-fourth of the width of the neighboring vertebræ.

Fig. 10. Lateral view taken at the same time as Figure 9, showing a narrowing of the first lumbar intervertebral space. The neighboring surfaces of the first and second lumbars are moth-eaten in appearance.

Both the anteroposterior and lateral views show a well maintained intervertebral space between the second and third lumbars and an increased width of the intervertebral space between the third and fourth. There are a few bone fragments in the soft tissues around the destroyed vertebra. Despite the marked destruction, there is no change in the physiologic curve of the vertebral column, which, according to Sgalitzer, is a constant and im-

portant finding in tuberculous spondylitis. The roentgenologic diagnosis of metastatic tumor was made. At postmortem examination the third lumbar vertebra was found to be completely collapsed and its substance to be replaced by a yellowish necrotic material, so that the vertebral body showed several circumscribed yellowish areas in the region of the spongiosa. The fourth lumbar vertebra showed only a slight destruction in its upper portion. The discs contained a large amount of yellowish granulating tissue. The diseased vertebræ were surrounded by a small paravertebral abscess containing a few calcified foci. The smear from the pus was positive for tubercle bacilli. Besides the tuberculous spondylitis the patient also had a chronic caseous tuberculous epididymitis, funiculitis, and seminal vesiculitis.

Fig. 11. Typhoid spondylitis. Roentgenogram taken 39 days later shows tremendous new bone production between the neighboring surfaces of the first and second lumbar vertebræ, mainly on the left.

Figures 3 and 4 are postmortem films of a lumbar vertebral column showing considerable amount of irregular bone destruction throughout the left borders of the first, second, and third lumbar vertebræ. The left borders of these vertebræ are surrounded by large irregular spurs. There is a large spur between the neighboring borders of the anterior parts of the second and third lumbar vertebræ. There is evidence of bone destruction on the anterior surfaces of the first and second lumbar vertebræ also. The intervertebral spaces show no narrowing and the

Fig. 12. Lateral view shows the disc to be narrower than at the previous examination. The neighboring vertebral surfaces of the first and second lumbar vertebræ show evidence of bone condensation.

proximal and distal surfaces of the involved vertebræ are smooth. There is a paravertebral abscess along the left borders of the first to fourth lumbar vertebræ.

Fig. 13. Appearance of typhoid spine twenty and one-half months after the first examination. The first and second lumbar vertebræ are ankylosed by dense bony bridges. Same case as shown in Figures 9 to 12.

At autopsy an abscess cavity measuring 2 cm. in diameter was exposed on the under surface of the manubrium sterni, with extensive necrosis of the bone. Examination of the spine showed a large fluctuating abscess cavity surrounding the left borders of the first to fourth lumbar vertebrae. The sections of the second vertebral body showed extensive caseation, with fibrosis and round-cell infiltration. The bacteriologic examination of the pus from the parasternal and paravertebral abscesses showed numerous tubercle bacilli.

That the roentgenologic appearance of a tuberculous spondylitis may imitate that of a deforming spondylosis is well demonstrated in Figures 5 and 6. These postmortem films show a slight lipping of the vertebral bodies. The right borders of all the vertebral bodies, are overbridged by large, irregular spurs which are most marked between the first and second, and second and third. There are numerous larger and smaller spurs on both the left and anterior borders of the lumbar vertebræ. The right sacroiliac joint is completely obliterated. The vertebral bodies are slightly irregular in outline. The bones are not atrophic.

The films taken at two different occasions within the last half-year prior to death showed the lumbar intervertebral spaces to be fairly normal in width. The psoas shadows appeared to be a little fuller than normal, but the appearance was not definite enough to warrant the diagnosis of a psoas abscess. All the roentgenologic findings were in favor of a deforming spondylosis, the main points being the generalized involvement of the entire lumbar column, the large hypertrophic spurs, and the well maintained intervertebral spaces.

At autopsy the prevertebral fascia over the entire lumbar spine was found to be greatly thickened, and the overlying adjacent structures were densely adherent. Incision into the tissue revealed a thin, yellowish-green pus, while the psoas muscles were yellowish-green in color. Incision here revealed numerous small cavities lined by rough, shaggy, irregular walls. All the intervertebral discs of the lumbar spine were eroded and replaced by a greenish, thick fluid, smears of which exhibited numerous acid-fast bacilli and other organisms. The lateral view of a section of the removed lumbar vertebra (Fig. 6) shows very beautifully the destruction of the discs, which could not be recognized on the original films. It also shows the irregular contours of the vertebral bodies. The bone trabeculæ throughout the arches and bodies are rearranged, some of them are thinned, others are surrounded by smaller and larger areas of new bone productive patches, giving the mottled appearance.

The above three cases showed unusual manifestations of tuberculous spondylitis. They presented one common feature: that

is, the intervertebral spaces were not narrowed, despite a proven tuberculous spondylitis. In the first case they were even wider than the neighboring discs, due to a large amount of granulating tissue which apparently held apart the vertebral bodies. This patient's roentgenograms yielded the typical appearance of a metastatic tumor. There were areas of calcification situated so close to the bone that they suggested bone débris rather than calcification. The clinicians were more correct than the roentgenologist, for, being unbiassed, they did not consider the widening of the discs contradictory to tuberculosis, possibly not having been influenced by the dogmatic roentgenologic postulate of the narrowed intervertebral space. The clinical evidence of tuberculous prostatitis and epididymitis justified them in looking upon the vertebral lesion as of a similar etiology.

In the third case, despite the liquefaction of the discs, the intervertebral spaces were not narrowed, this lack of collapse evidently being due to the large hypertrophic spurs that overbridged the intervertebral spaces. An unusual number of the discs and vertebral bodies were involved in this case. The involvement of two or three vertebræ in tuberculous spondylitis is common, as are multiple lesions of the vertebral column, though the involvement of the entire lumbar column is rare. The bones were not atrophic and the roentgenologic appearance was quite suggestive of a spondylosis deformans, produced by degenerative changes rather than by an infectious process, although one would have expected a more marked lipping and deformity of the vertebral bodies in an advanced spondylosis.

Despite the general belief, areas of new bone production around tuberculous vertebræ are not uncommon, mainly in slowly developing benign cases, but such a marked overbridging of tuberculous vertebræ as this case shows is rare. One can not but think that this case is not a clear-cut tuberculous spondylitis and that the excess bone production was partly caused by the other infectious organisms found in the discs.

The intervertebral discs of the second patient's vertebræ were not examined pathologically, but on the roentgenograms the discs did not appear to be narrowed, and there was a large amount of new bone formation around the borders of the involved vertebræ. This is much in contradiction of Baetjer and Waters' (3) statement that new bone formation does not occur in non-tuberculous spondylitis.

Fig. 14. Lateral view showing a marked narrowing of the disc and osteosclerosis of the neighboring surfaces of the first and second lumbar vertebræ. Same case as shown in Figure 13.

METASTATIC TUMORS

The most common appearance of localized metastatic tumors is a wedge-shaped

collapse of the vertebral body, with well maintained intervertebral discs.

Figure 7 shows an unusual behavior of the disc. The film was taken at 2 hours after the injection of lipiodol into the cisterna magna and shows a complete stoppage of the contrast material at the level of the upper border of the fifth dorsal vertebra. The lower half of the sixth dorsal vertebra and the upper surface of the seventh are markedly destroyed, and the intervertebral space between these two vertebræ is obliterated so that the destroyed surfaces of the two neighboring vertebræ impinge on each other. There is a kyphosis at this level. The roentgenologic appearance of this case was not unlike a tuberculous spondylitis. All the vertebræ were atrophic, and there was no evidence of regenerative changes. There was a kyphosis at the site of the lesion and an absence of the shadow of the disc. Without a clinical history of the previous removal of a malignant thyroid, the diagnosis of a metastatic tumor could not have been made roentgenologically. At subsequent autopsy, metastatic tumors of the sixth and seventh dorsal vertebræ, with involvement of the spinal cord and herniation of the disc into the vertebral bodies, were found, secondary to an adenocarcinoma of the thyroid.

Wagoner and Pendergrass (38), in a recent publication, also pointed out that "fractures, metastatic processes, and tuberculous caries of the vertebræ may at some stage of the disease simulate each other" and that "the intervertebral disc may disappear in metastatic tumors, probably due to herniation into the body of the vertebra at the weakened point near the seat of metastasis."

Figure 8 demonstrates herniations of the discs and subsequent narrowing of the intervertebral spaces between the eighth and ninth, ninth and tenth dorsal vertebræ; between the first and second, and second and third lumbar vertebræ into the vertebral bodies, in a case of widely generalized osteolytic metastatic tumors, secondary to a carcinoma of the right breast.

TYPHOID SPINE

Spondylitis typhosa is always a disease of the convalescent stage of typhoid fever. It occurs principally in adults, between the ages of 15 and 35, though in rare instances it has been observed in children and older individuals. Men are more subject to this disease than women, the ratio being 85 : 15 per cent. It seldom occurs before the seventh week after the onset of illness, there usually being a symptomless interval between the typhoid fever and the onset of the spinal symptoms, amounting to from three to eight weeks. However, there are cases reported in which this interval was from three to eight months. In Puhl's (27) case the typhoid spondylitis developed ten years after the typhoid fever. Such cases, however, are rare.

The disease usually begins with indefinite, slight pain that rapidly increases in intensity and may become agonizing. In such cases the slightest motion aggravates the pain and turning becomes almost unbearable. Some cases, however, are mild and may escape detection. According to various statistics, typhoid spondylitis occurs in between 0.18 and 2.7 of all cases of typhoid fever. The course of the disease, according to Puhl (27), is variable, but seldom fatal; consequently the pathologic data are scant. Fraenkel (12) was able to demonstrate typhoid bacilli in the vertebræ of his autopsied case.

The disease has two forms: (1) the spondylitic and (2) the perispondylitic. In the first form, which is rare, necrotic areas occur in the vertebræ and transverse processes. The vertebral body may collapse. In the second form, the involvement is mainly localized in the periosteum and disc. This form represents the most common manifestation of typhoid spondylitis.

According to Krause (19), during the first stage of the disease the roentgenologic findings are negative, but from three to six weeks later changes of the intervertebral spaces are demonstrable. They become more opaque; their width diminishes,

and finally the two vertebræ unite. At times, in the early stage of the disease, irregularities of the vertebral bodies are demonstrable, while changes in the vertebral bodies seldom are. Periosteal new bone production is common.

We have had the opportunity of observing two cases of typhoid spondylitis.

J. B., aged 35 years, white, male, was admitted to Cleveland City Hospital with typhoid fever. The Widal reaction was positive and typhoid bacilli were cultured from the blood. Blood Wassermann was negative. For 22 days the patient ran a septic fever averaging between 39° and 40° C., and then the temperature curve gradually came down to normal. He was discharged, improved, on the seventy-fourth hospital day.

On the one hundred forty-fifth day after the onset of illness he was readmitted, complaining of severe pain in the lumbar region, of four weeks' duration. The pain had become gradually worse, making it impossible for him to twist or move. On physical examination there was found to be slight tenderness over the lumbar spine; no rigidity of the muscles. Most of the pain was elicited by the patient moving in bed. His temperature varied between 37° and 38° during the first four weeks of his stay in the hospital. Roentgen studies of the spine at this time showed a marked left scoliosis of the entire lumbar arch. The neighboring surfaces of the first and second lumbar vertebræ were moth-eaten in appearance and the disc between them was narrowed (Figs. 9 and 10). The patient was placed in a body cast at this time and his pain became less severe.

A checkup examination 39 days later showed a remarkable change. The scoliosis disappeared and the narrowing of the disc became more marked. There were large, irregular bony spurs around the neighboring borders of the first and second lumbar vertebræ, which overbridged the intervertebral space (Figs. 11 and 12). No bone atrophy was noted. At subsequent examinations the outlines of the neighboring surfaces became more clear-cut, and the hypertrophic spurs more dense and more sharply defined. The pain gradually decreased and the patient was discharged symptomless two months later.

Fig. 15. Typhoid spondylitis showing ankylosis between the second and third lumbar vertebræ by large bony spurs. There is a paravertebral abscess on the left, displacing the left kidney laterally.

The last examination, 15 months later, showed a marked narrowing of the disc, a slight osteosclerosis of the neighboring surfaces of the involved vertebra, and powerful bony spurs, producing an ankylosis between the two vertebræ (Figs. 13 and 14). The patient was symptom-free.

C. G., white female, 48 years of age, about six weeks before admission experienced a sudden pain in the left side of the back, which radiated downward to the perineum and to the inner side of the thigh. The pain was so severe that it kept the patient awake at night. There had been occasional vomiting during the previous two weeks.

On physical examination a firm mass about the size of a small grapefruit, which did not descend with inspiration, was palpated in the left upper quadrant. The

temperature ranged between 37.5° and 38.8°. On admission, the red blood count was 4,340,000, the white blood count

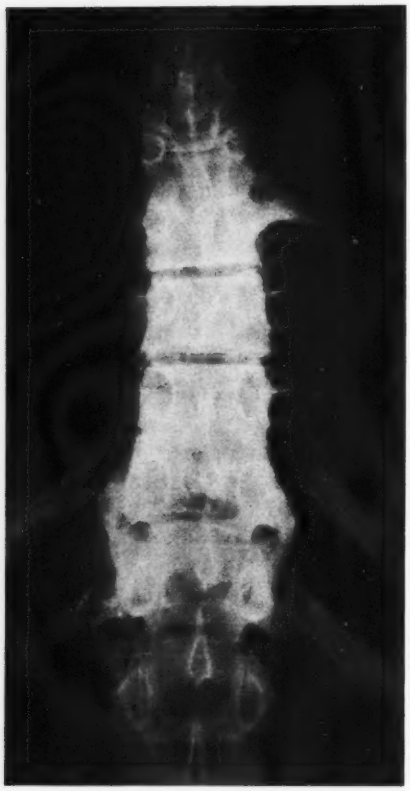

Fig. 16. Osteomyelitis of spine showing complete fusion of the seventh and eighth dorsal vertebræ due to destruction of the disc, and marked narrowing of the intervertebral space between the tenth and eleventh dorsal vertebræ, with marked spur formation between the borders of the eleventh and twelfth dorsals.

21,800, and blood smear showed 84 per cent polymorphonuclears. The urine contained albumin and three + sugar.

A film of the abdomen taken on admission showed the second and third lumbar vertebræ to be united by dense bony spurs, with an almost complete disappearance of the disc. The left kidney appeared to be displaced to the left by a mass situated near the left borders of the second and fourth lumbar vertebræ (Fig. 15). The shadow of this mass merged with the shadow of the kidney. Subsequent pyelograms showed a fairly shallow defect on the inner upper surface of the left kidney. The findings were thought to be due to either a kidney tumor originating in the cortical substance of the inner and upper part of the left kidney, or to an extrinsic tumor, causing a pressure defect. The lesion of the spine was diagnosed as an old infectious spondylitis. Little attention was paid to it roentgenologically or clinically, because the overbridging was so dense that the appearance suggested an old process.

At operation, the abdominal mass was exposed, a small incision being made through the peritoneum into it, following which a large quantity of thick, green pus was evacuated. Two rubber drains were inserted and the abdomen quickly closed. The patient died the day following the operation. The culture from the pus yielded colonies of typhoid bacilli.

Apparently this patient had an ambulatory typhoid fever some time before her present illness started, her condition being caused by a typhoid spondylitis and a paravertebral abscess. At that time we did not realize how rapidly new bone productive changes could occur in typhoid fever and neglected to pay sufficient attention to the spinal lesion. The previous case, however, taught us that in this disease large spurs may form during a few weeks' time. The patient had not given a history of a preceding illness and, due to her death, we were unable to check the clinical history. The roentgenologic appearance of both our cases is in accord with the majority of published cases (Krause, 19, Margulis, 24, Van Eden, 37, Lyon, 23, and others) in which, according to the summary of Lyon, "a narrowing of the intervertebral disc, participation of the end-plates of the neighboring vertebræ, without evidence of a deeper bony lesion, periosteal bone production, and rapid regression of the inflammatory and destructive changes" occur. The narrowed disc and the bony bridges remain as signs of the previous disease.

However, Schmorl (29) published a case of typhoid spondylitis in which the disease was represented by such marked destruction of the tenth dorsal vertebral body that the body collapsed and only the upper and lower end-plates remained intact. The intervertebral discs above and below the destroyed vertebra were of normal width, and the end-plates of the diseased vertebra were smooth.

INFECTIOUS SPONDYLITIDES

In infectious spondylitides caused by syphilis, strepto- or staphylococci, influenza bacilli, pneumococci, etc., the behavior of the disc is also variable. In certain cases the process involves the end-plates and the intervertebral discs; in others, it is more localized in the bone. In most of the cases a considerable amount of new bone forms. In the more virulent instances osteolysis is predominant.

The following cases demonstrate that the disc may or may not be destroyed in osteomyelitic spondylitides also.

C. F., white male, aged 23, was admitted to the Cleveland City Hospital with a swelling in the left lumbar region of 15 months' duration. The patient had had an osteomyelitis of the left tibia ten years before, followed by an osteomyelitis of the left humerus.

On examination, a fluctuant area of swelling and redness was found in the right lumbar region, extending from the posterior axillary line to the spine and measuring five to six inches in length. On the day of admission the abscess was incised and about three ounces of thick pus obtained, culture from which showed nonhemolytic streptococci. Acid-fast stains showed no evidence of tubercle bacilli.

Roentgenograms taken on admission showed the seventh and eighth dorsal vertebræ to be completely fused, with no evidence of spur formation. The vertebral end of the eighth right rib, however, showed a marked osteosclerosis (Figs. 16 and 17). The intervertebral space between the tenth and eleventh dorsal vertebræ was markedly narrowed, while the tenth vertebra was deformed, there being a defect on its anterior surface and the body being slightly wedge-shaped. The

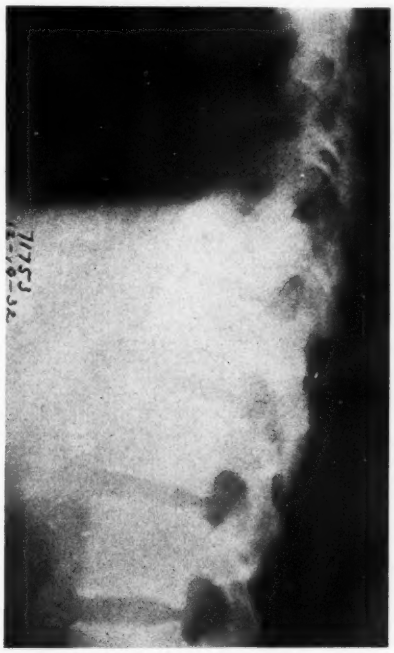

Fig. 17. Lateral view of the same case as shown in Figure 16, showing the marked narrowing of the intervertebral space between the tenth and eleventh dorsal vertebræ, with bone destruction around the anterior part of the body of the tenth dorsal.

anterior border of the eleventh dorsal also showed some irregularity. There were large hyperostotic spurs between the borders of the eleventh and twelfth dorsals and between the twelfth dorsal and the first vertebra of the lumbar spine, and a slight gibbus between the tenth and eleventh dorsal vertebræ, which findings confirmed the clinical diagnosis of osteomyelitis of these vertebræ. From a roentgenologic standpoint the differentiation between a tuberculous and an infectious spondylitis could not have been made, though the diagnosis was established with the aid of the clinical history and the laboratory findings.

Through the courtesy of Dr. Steel and Dr. Harbin, of Lakeside Hospital, Cleveland, we are able to show the appearance of an osteomyelitis of the upper end of the

Fig. 18. Osteomyelitis of the spine showing destruction of the neighboring surfaces of the fifth lumbar and first sacral vertebræ, with a complete disappearance of the disc and spondylolisthesis formation.

sacrum and lower part of the fifth lumbar vertebra, in a pathologically proven case. The lateral view shows a slight destruction of the lower surface of the fifth lumbar vertebra and the upper surface of the sacrum. The fifth intervertebral disc is destroyed and, due to a destructive process throughout the small joints between the sacrum and fifth lumbar vertebra, a spondylolisthesis developed (Fig. 18). At postmortem examination the lesion was found to be surrounded by a large retroperitoneal abscess, the pus of which contained streptococci as did the culture from the blood. This case will be reported in detail by Dr. Harbin.

Figure 19 shows the unusual appearance of an osteomyelitic process of the first lumbar vertebra, involving the epiphyseal rings but not the discs, which was metastatic in origin. The patient was a 14-year-old white female who died as the consequence of an acute vegetative endocarditis of the mitral leaflets and staphylococcus septicemia. At autopsy a fusiform collection of liquid yellow pus was found in the region of the first lumbar vertebra; the periosteum over the anterior surface of the first vertebra was elevated by an extension of the abscess and the bone underneath it was slightly irregular and roughened. Sections of the bone and smears of the pus did not reveal the presence of tubercle bacilli. A roentgenogram of the specimen showed a slight bone destruction on the anterior surface of the first vertebra of the lumbar spine. The upper and lower epiphyseal rings of this vertebra were elevated and their surfaces facing the vertebral body showed a slight irregularity. The intervertebral disc above and below the lesion were well maintained and sharply defined in this case.

Reviewing the literature one can find that osteomyelitis of the vertebræ is often diagnosed as tuberculous spondylitis. Kastner (16) reports a case in which, during the course of the disease, different roentgen examinations showed a typical appearance of tuberculous spondylitis. Only in a later stage of the disease was the correct diagnosis made, when bony bridges and areas of condensation developed. LeFort and Ingebraus' (20) case also showed the roentgenologic appearance of a Pott's disease, but the bacteriologic examination of the blood yielded *Staphylococcus aureus.* Their second case also showed all the roentgenologic symptoms as of tuberculous spondylitis. Fraenkel's (12) second and third cases showed complete destruction of the disc in osteomyelitis imitating tuberculous spondylitis. Borchers (7), in his discussion of osteomyelitis of the spine, states that roentgenologic diagnosis of this lesion during the first two weeks of the disease is impossible. In later stages the trabeculæ

rarefy and the outlines of the vertebral body become irregular. The roentgenologic differentiation between tuberculous and osteomyelitic spondylitis is often impossible.

CONCLUSIONS

Wagoner and Pendergrass (38), Ellmer (11), and Freund (13) have published statements which appear to be confirmed by our investigations. The changes of the intervertebral disc can be evaluated only as an index of a vertebral lesion. Due to the close relationship of the vertebra and disc, not only tuberculosis, but the great majority of infectious spondylitides may extend into the disc during some stage of the disease. A primary infection of the disc is possible in younger individuals without involvement of the vertebral body, producing a marked narrowing or a complete obliteration of the intervertebral space on the roentgenogram. Schmorl demonstrated that herniation of the disc may occur in cases of fracture of the vertebral body, and that narrowing of the disc may also be present. As the fracture heals, periosteal callus develops and, because of the narrowed disc, the roentgenologic differentiation between an old trauma and an old infectious arthritis becomes extremely difficult in some cases.

Although in the great majority of instances the disc is definitely narrowed on the roentgenogram in tuberculous spondylitis, cases are known in which the width of the disc was not changed and in one of our cases was even wider than normal. Paravertebral abscesses occur most commonly in tuberculous spondylitis, but have been found also on numerous occasions around osteomyelitic processes and in one of our cases in the neighborhood of a typhoid spine.

Sgalitzer in his publication (31), to which there is a very general reference in the world literature, is inclined to suspect tuberculosis whenever there is a change in the physiologic curve of some vertebral segment. He pays too much attention to the narrowing of the disc as an important sign of the spondylitis. Two of his illustrations (Figs. 6-*A* and 6-*B*) show a diminished width of the seventh and eighth dorsal vertebræ, with a narrowing of the disc between them, in a 46-year-old man, but the illustrations also show typical Schmorl's nodes on the lower borders of the seventh and eighth dorsal vertebræ and a small calcified patch in the ninth intervertebral disc. This appearance is quite characteristic of cartilage herniation rather than of tuberculosis. Despite the thoroughness and excellency of this publication, we feel that Sgalitzer was too dogmatic in his roentgenologic diagnosis of tuberculous spondylitis.

Fig. 19. Unusual appearance of an osteomyelitic process of the first lumbar vertebra, showing the destructive process to be situated on the surfaces of the epiphyseal rings facing the vertebral body. The epiphyseal rings are elevated. The intervertebral spaces are of normal width. The normal epiphyseal rings above and below the involved vertebræ are well visualized.

In a vertebral lesion, be it due to tuberculosis, pyogenic infection, or localized metastatic tumor, the roentgenologic appearance is possibly of greater importance than ony other single clinical factor, as it enables the clinician clearly to visualize the location, extent, and progress of the lesion. There are certain generalized arthritic processes like spondylosis deformans (hypertrophic arthritis) and spondylarthritis ankylopoietica (Strümpell-Marie's disease) in which the roentgenologic appearance is clear-cut. Primary benign and malignant tumors and generalized metastatic tumors of the vertebræ can be diagnosed with great accuracy, as well as recent fractures, congenital anomalies, and some of the diseases described recently by Scheuermann and Schmorl, but the differential diagnosis between certain old vertebral fractures, chronic tuberculous spondylitides, and chronic infectious spondylitides on the one hand, and localized metastatic tumor and acute tuberculous or infectious spondylitides on the other hand, is often difficult and cannot be made with certainty. Repeated examinations are of great value in the differential diagnosis between a tuberculous and an infectious spondylitis (for in the latter disease new bone formation occurs in relatively early stages of the disease), but may fail one in the differential diagnosis between localized metastatic tumor and acute tuberculous spondylitis.

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THE RELATIVE VALUE OF STEREOSCOPIC AND SINGLE FILMS IN THE ROUTINE EXAMINATION OF THE CHEST[1]

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IT is becoming increasingly clear that the only real hope of materially diminishing the present incidence of tuberculosis lies in an earlier diagnosis than is possible by awaiting suspicious symptoms, or even by a physical examination. Such a diagnosis can be obtained only by systematic roentgen examination of large numbers of apparently healthy individuals.

Certainly, all known contacts of every active case of tuberculosis should have roentgen examination, but this is not sufficient, as many patients spread the infection for months or years before their condition is diagnosed. Extensive surveys of large groups by the roentgen method are becoming, therefore, more and more frequent. Such surveys have almost invariably detected enough unsuspected cases to more than justify the expense involved. Nevertheless, they are expensive, and in many cases impossible on that account alone. In such a survey, the cost of films and chemicals is a major item, so, if a single film can be substituted for the stereoscopic pair, the cost can be reduced materially. This may permit such surveys to be made in many groups in which it would be otherwise impossible. As a matter of fact, many of the tuberculosis surveys which have been made, notably those by Chadwick and Zocks (1), and by the University of Minnesota Health Service, were done with the single film. Some criticism has been directed at these on this account.

There is a wide difference of opinion among roentgenologists regarding the necessity of stereoscopic films for chest examination. The stereoscopic method for chest examination is said to have been originated by Wenckebach. A demonstration by Lenhardt and Kiessling, at the first Roentgen Congress in 1905, attracted wide attention. It was not, however, until later that much precise knowledge of pulmonary shadows in terms of pathology began to accumulate. The x-ray generators available during this period were not sufficiently powerful to produce plates possessing fine detail, consequently, the stereoscopic method was of great assistance in recognizing and evaluating any changes present. Gradually, the stereoscope came to be considered indispensable. Dunham (2), in 1918, said, "The single plate adds practically nothing to the fluoroscope," and again, "The stereoroentgenogram is essential to the complete roentgen examination of the chest." However, as technic and apparatus have improved, and the flat plate has shown greater and greater detail, these ideas have become of doubtful validity, and many excellent radiologists disagree or agree only with reservations.

Forssell (3) was of the opinion that a good single film, carefully studied, provided as much information as a stereoscopic set. Holmes and Ruggles (4) say, "It is not necessary to take stereoscopic films as a routine procedure, but, in selected cases, they may be of considerable value." Sante (5) says, "While stereoscopic examination is especially helpful in cases requiring critical examination of the fine lung structure, it is not, in our opinion, essential in all cases. One can acquire great skill in the interpretation of flat films of the chest." Wessler and Jaches (6) considered a good flat film superior to a mediocre stereoscopic set, while the U. S. Army Manual (7) says, "Stereoscopy

[1] Presented before the Minnesota Radiological Society, Feb. 13, 1932.

can, however, usually be dispensed with, as the data it furnishes do not differ in character from those found in a good single film."

Despite such authority for the value of the single film, there remains, among the greater number of radiologists, a firmly fixed conviction that stereoscopy is essential in chest diagnosis. This is less true in Europe, where single or multiple flat films are commonly used, but in this country, stereoscopic films are made routinely in almost every institution in which chest work is done, even in places where no plate changer is available and the two plates cannot possibly be made without intervening motion on the part of the patient. That such films can have no value in the accurate production of a three-dimensional image seems never to occur to those performing the examination.

In office practice, the situation is entirely different from that in institutional work, or in routine examination of groups such as school children, university students, tuberculosis contacts, and in insurance or military physical examinations. For instance, the overhead and the cost of the trained opinion of the practising radiologist are the major factors in determining charges, and this is true to such an extent that the cost of an extra film in a chest examination is scarcely to be considered. Moreover, since in office practice the bulk of the patients are persons in whom there is some cogent reason to suspect pathology, it would be a most shortsighted policy and would risk one's reputation as a diagnostician to save one film, or even three or four, on an examination. Granting all this, however, there is grave doubt in our minds whether the routine use of stereoscopic films is the most advantageous way of using an extra film in chest diagnosis. Certainly, there are many cases in which lateral or oblique films, or one light film and one dark film, or an antero-posterior and a postero-anterior film, or lateral decubitus films for fluid, or special films of the apices, give far more information than stereoscopic films can possibly do. Each case must be considered on its own merits, and, in case of doubt, a flat film will give as much information as a stereoscopic pair in determining the best procedure for further examination.

On what, then, does the value of stereoscopic examination depend? We believe all will agree that the following three factors constitute its chief value as contrasted with the flat plate:

1. The ability to recognize at a glance three-dimensional relationships.
2. The ability to recognize as artefacts certain shadows which may be seen in one film and not in the other.
3. The relative change in the position of various shadows which permits images obscured in one plate to be seen in the other.

Of these three factors, the first is the only one which requires the use of the stereoscope, since it goes without saying that no shadow can be discerned in the stereoscope which does not appear on at least one of the films constituting the pair. It must also be remembered that *unless a particular shadow appears on both of the plates with sufficient distinctness for corresponding points within it to be readily identified*, any judgment of the depth of the shadow can be only a subjective illusion, with no valid basis in the physics or optics involved.

Thus, the value of the three-dimensional image is open to question, and it is a matter of daily experience that even expert radiologists will differ in judgment as to the position of the same shadow on the same pair of plates. Measurement of the shift of corresponding points in the two plates relative to other known points, is, in reality, a more reliable, although somewhat more cumbersome, method of estimating third-dimensional relationships. However, even this method becomes unreliable if the slightest movement is allowed to occur between the exposure of the two films. Even a slight respiratory movement between exposures can cause lung markings to appear anterior to the anterior ribs,

and the authors have seen tuberculous cavities which appeared to occupy the same position. In many cases, the distortion is so obvious that it is readily discounted but more often it is not. Even the absence of respiratory movement does not insure a true stereoscopic effect because, as has been shown, even in plates exposed for one-twentieth of a second there is often motion due to the heart, and, while probably not a very serious factor, it does cause distortion in the parts adjacent to the heart.

It follows, therefore, except in unusual cases, that no information is made available by the use of the stereoscope which may not also be obtained by the comparison of the same two plates side by side in the viewing box. This method has been employed to a large extent by one of us for many years. This again raises the interesting question of whether it would not be better, as a routine procedure, to substitute for the usual stereoscopic pair one made in the same way but with different exposures—a method which was long ago suggested but has never been widely adopted (8). These could be read side by side in the viewing box. The shift would provide the second and third advantages of stereoscopic films, as listed above, and it is well known that certain types of lesion show up best in a thin and others in a dense film. This problem is, however, outside the scope of the present discussion.

Waring (9), in 1924, took considerable pains to demonstrate that, in the adult, 48.4 per cent of the lung-fields are covered by one rib shadow and 20.77 per cent by two rib shadows, on the assumption that an early lesion which can be distinguished through the rib shadow will be burned up if in a free area, while one visible in a free area will be obscured by an overlying rib. Experience has shown that this assumption is not valid unless the contrast gradient of the film is too steep as the result of too high voltage. In a good film, even a minimal lesion will rarely be completely obscured by rib shadows, and then only in the rare case in which no part of the lesion overlaps the free areas or areas covered by single rib shadows.

It has been our impression for some time that the technical factors have been sufficiently perfected that rarely, if ever, will any lesion be completely obscured on any good single film. Should this impression prove correct, it would follow that little or no pathology would be missed on the single film, and that any mistakes which did occur would be, rather, in the nature of interpretation of the presence of lesions that did not exist. In such a case, the real value of the stereoscope would lie in helping to evaluate shadows of questionable significance observed on a previous single-film examination. Included among these will be such artefacts as may simulate abnormal shadows.

In the routine examination of large groups of persons, a real saving could, therefore, be effected with no loss in efficiency if the following points could be definitely established:

(1) That no pathology will be overlooked which would have been picked up on stereoscopic examination;

(2) That the total number of cases requiring re-examination to evaluate doubtful shadows, will not be large enough to offset the savings on the original examination.

As a test of the above points, we determined to compare the diagnosis of stereoscopic films with the diagnosis of a single film taken from the same pair. Five hundred such pairs were taken from our files in consecutive groups of from fifty to one hundred, and one film from each pair was selected at random from which to record a careful and detailed diagnosis. Later, each pair was examined with the stereoscope and a second diagnosis was recorded. Then, the two independent diagnoses were compared with each other and the discrepancies were checked with a third examination of the films, both as stereoscoped and as two flat plates. The third combined examination by the two

TABLE I

		Single Film Examination			
		Considered pathologic	Considered doubtful	Considered normal	Total
Combined examination	Pathologic	360	9	0	369
	Normal	13	32	86	131
	Total	373	41	86	500

methods was taken as the criterion of correctness in the examination.

Because the proportion of incipient to moderately or far advanced cases in this material is probably smaller than in the usual large tuberculosis survey, an attempt was made to offset this factor in the following manner. For each film or stereoscopic pair a detailed description of the pathology was recorded, covering the nature of the lesion or lesions and their extent. Each area of pathology was then considered separately in such a manner that, if any one area was recorded as normal when pathologic, or pathologic when normal, it was considered that that film was incorrectly diagnosed, regardless of how many other areas on the same film had been correctly recorded. The results of the study are listed in Table I.

It will be noted that in no case was a patient diagnosed as normal on the basis of the single film who later was found to show pathology on the combined examination. Thirteen cases thought to be abnormal on the single film proved to be normal on the combined examination, while 41 cases were considered doubtful on the single-film examination.

In attempting to evaluate the significance of this figure, we consulted Dr. A. E. Treloar, Assistant Professor of Biometry at the University of Minnesota. By assuming that the bivariate distribution conforms reasonably with the normal surface, it is possible to calculate the correlation coefficient, r, by the tetrachoric method. This turns out to be 0.98, a very high correlation, both when the doubtful cases are grouped with the normals, and when they are divided between pathologic and normal in the ratio of total pathologic (369), to total normal (131). If the doubtful cases are grouped with the pathologic cases, the correlation is still higher. Accepting 0.98 as the correct coefficient, the "expected frequency" in this cell of the table turns out to be 1.6 per 500 cases rather than 0, the observed value. This is in reasonable accord with the observed value. Moreover, when r is calculated by the "equivalent probability method," which is independent of normality of distribution, it appears that r is greater than 0.95, the highest correlation to which the method is suited. This would suggest that the assumption of distributional normality is justified.

Accepting, therefore, 1.6 as the expected number of lesions which will be overlooked by the single-film examination of 500 cases, it appears that the error in this respect will amount to 0.3 per cent of the total, or to 0.4 per cent of the pathologic cases. As the proportion of pathologic cases is far higher in this material than in the usual tuberculosis survey, the latter figure, *0.4 per cent of the pathologic cases*, seems a more appropriate basis of calculation.

From this, it is reasonably clear that the number of tuberculous patients missed by flat-film examination will be insignificant, but it remains to be demonstrated that enough re-examinations will not be required to offset the saving effected by their use. This is impossible to determine without knowing how many early cases will be found in the particular survey under consideration. We do not believe that any patient should be diagnosed as tuberculous on the basis of a single film unless the pathology is so obvious as to be unmistakable. Since, however, the purpose of the examination is to locate these particular cases

for purposes of further study, it seems permissible to dismiss all such re-examinations from consideration unless they fail to substantiate the original diagnosis. In our material there were 13 such cases, which, with the 41 cases showing doubtful areas, makes a total of 54 in which re-examination would have been required on this basis. Of the 41 doubtful cases, there were 11 which, in addition to the doubtful area, contained other areas of obvious pathology. These would not have been re-examined in the ordinary course of events. Including the entire 54, however, there would be left only 11 per cent requiring re-examination. This is, at best, only an indication of what may be expected, and it must be determined in each individual survey whether or not the number of re-examinations is likely to offset or more than offset the saving. In many surveys, the percentage of entirely normal cases may be as high as 95 per cent.

In a study of this type it is impossible to eliminate the personal equation, and certain variations must be expected according to the ability of the individual to interpret more correctly with or without the stereoscope. Either type of interpretation will be reliable only in the hands of a trained roentgenologist, and we cannot emphasize strongly enough that there is no magic about the stereoscope: it will not permit any save an experienced roentgenologist to make dependable diagnoses in other than the most obvious lung conditions. In fact, the stereoscopic method probably requires more, rather than less, skill in interpretation to avoid error.

CONCLUSIONS

1. Rarely will a single chest film of good quality, and carefully studied by a trained roentgenologist, fail to show any lesion which would have been demonstrated by a stereoscopic pair.

2. The expected value for such failure, as shown by this study of 500 cases, is 0.4 per cent of the pathologic cases.

3. In routine tuberculosis surveys a considerable saving can be effected without significant loss of efficiency by the use of the single film, unless the particular material involved requires enough re-examinations to offset the savings.

4. In office practice, on the other hand, some type of multiple-film examination is much to be preferred.

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A CASE OF RIGHT-SIDED ATYPICAL DIAPHRAGMATIC HERNIA

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DIAPHRAGMATIC hernia as a clinical entity has of recent years become so common a finding that it would be superfluous to report a single case unless there were something unusual in regard to anatomy, diagnosis, or treatment.

Diaphragmatic hernias are divided by most observers into two main types: traumatic and non-traumatic. The non-traumatic type is practically always congenital. These two types are cross-divided into so-called "true hernias," or those in which there is a hernial sac, and those without a sac, so-called "false hernias." Either type may be congenital or acquired. While we have said that non-traumatic hernias are nearly always congenital, we mean that, as in the case of other herniations from the abdominal cavity, there is a muscular weakness or deficiency which predisposes to the development of hernias later in life, if it is not already partially present at birth.

If the herniation is present at birth, it is due to embryologic deficiency, usually without an enclosing sac. The most common sites of such herniations are: (1) through the esophageal opening; (2) through the foramen of Bachdoleck (hiatuspleuro peritonalis); (3) through the dome of the diaphragm; (4) through the foramen Morgagni; (5) through the congenital absence of the left half of the diaphragm. Hernias which are non-traumatic and acquired following birth, but which may be included in the congenital group because of the congenital predisposition, take place usually at the same sites. If acquired after birth, the hernia as a rule has an enclosing sac. Traumatic types as a rule arise as a result of a crushing injury or puncture wound and usually herniate either through the esophageal opening or the posterior portion of the left side of the diaphragm. If along the esophagus, there is usually a sac, and if through the leaf of the diaphragm there is usually no sac. Of course, if there is direct injury to the diaphragm itself, the hernia may occur at any point. All of this information in regard to herniations of the diaphragm is already well established. Most of them, whether traumatic or non-traumatic, whether congenital or acquired, occur on the left side of the diaphragm in subjects who are cardiosinistra, since close apposition of the liver to the diaphragm usually prevents herniations on the right side. Greenwald and Steiner (15) state that the proportion is about 77 per cent on the left side and 20 per cent on the right, with about 2.5 per cent occurring on both sides.

We have looked through the literature of recent years and are unable to find a case corresponding to the one about to be discussed. In this case, herniation took place on the right side of the diaphragm posteriorly, behind the outer crus through the mesial lumbocostal arch; it was the distal end of the stomach, pyloric valve, and some six inches of the duodenum which were herniated. The fundus of the stomach and cardiac orifice remained in the abdomen underneath the left dome of the diaphragm. There was a well-defined ring in the diaphragm about the herniated organ, and the viscera that were herniated were covered by a sac, indicating that this herniation took place after birth (Fig. 1).

Case History.—The patient was a colored girl, 17 years of age, who entered the hospital on Friday evening with a diagnosis of ptomaine poisoning following the eating of sandwiches on the preceding Tuesday. She appeared emaciated and exhibited

pernicious vomiting. Prior to the onset of this attack the history was entirely negative for any gastro-intestinal complaints.

Physical Examination.—Patient was a slender, apparently under-nourished colored girl with a scaphoid abdomen, running no temperature. Percussion and auscultation sounds in the left chest were normal. In the right chest there was resonance anteriorly and superiorly, and dullness verging on flatness posteriorly. Auscultation revealed free fluid in the chest. Splashing could be heard on both sides but most marked on the right.

Clinical Diagnosis.—Hydropneumothorax of the right chest, with a question of possible diaphragmatic hernia. The patient was referred to the x-ray department for radiographs of the chest because of the suspected hydropneumothorax.

X-ray Examination.—Radiographs were taken of the chest postero-anteriorly and laterally recumbent. At this examination a well-rounded, dome-like viscus was seen in the middle third of the right chest, with air beneath and a fluid level higher than the diaphragmatic level (Figs. 2 and 3). The diaphragm itself could be seen some two inches lower. The lung-fields about the dome-like viscus were perfectly normal as were the chest findings on the left side. For this reason a tentative diagnosis of herniation of the stomach through the diaphragm was made. This examination was followed by a second one in which the patient was examined fluoroscopically while swallowing a barium meal. This meal passed straight down the esophagus and did not enter the viscus in the right chest but entered the abdomen through the normal opening in the diaphragm, the esophagus apparently leading to the bottom of the stomach instead of the usual cardiac orifice. The stomach fundus underneath the left diaphragm filled with the barium from the bottom up, elevating a column of supernatant fluid which the patient quickly vomited. She was then placed in the supine position and about half of the barium passed from the left side of the upper abdomen into the viscus in the right chest, thus establishing the diagnosis. The pyloric half

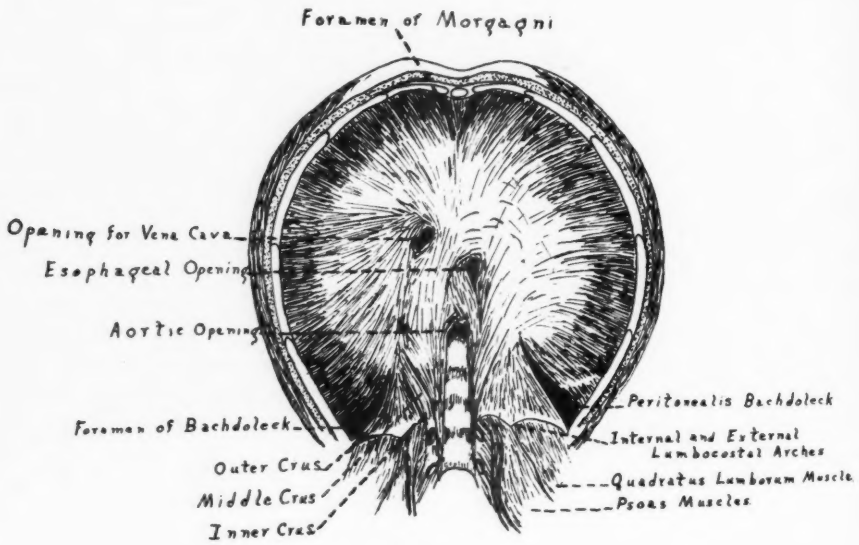

Fig. 1.

of the stomach was herniated through the right side of the diaphragm into the chest, taking with it six inches of the duodenum (Figs. 4 and 5).

The cause of the patient's suffering was now quite apparent. She had a high small intestinal obstruction due to incarceration of the duodenum where it passed through the hiatus in the diaphragm. As above mentioned, the abdomen was scaphoid; the intestines were practically devoid of gas. Since the patient had been more or less obstructed for some five days, an emergency operation was resorted to, performed by Dr. O. K. Parry.

Operation.—A high right rectus incision was made. The left lobe of the liver was lifted and the abdominal side of the hernia examined. Traction on the stomach or duodenum was of no avail, so the ring was incised in the posterior lateral direction. Traction again failing to reduce the hernia, a hand was inserted into the hernial sac, adhesions of the stomach released, and the stomach and duodenum drawn down into the abdomen. Interrupted sutures then repaired the incision in the diaphragm and closed the aperture. The stomach and duodenum showed subserous hemorrhagic changes at the site of constriction and considerable inflammation of the portion which had been incarcerated and partially strangulated. The distal half of the stomach and proximal six inches of the duodenum were contained in a large sac occupying the lower inner portion of the right pleural cavity and passing under the medial lumbocostal arch on the right side. The stomach was attached to the top and diaphragmatic surface of the sac by many fine adhesions. The opening in the diaphragm was about one inch in diameter. A portion of the duodenum and stomach in the thorax were considerably distended with gas and liquid.

Although the patient was given all the usual post-operative treatment indicated in an emergency of this kind, she was in no physical condition after five days of intestinal obstruction to withstand the post-operative shock, and died some five hours after the operation.

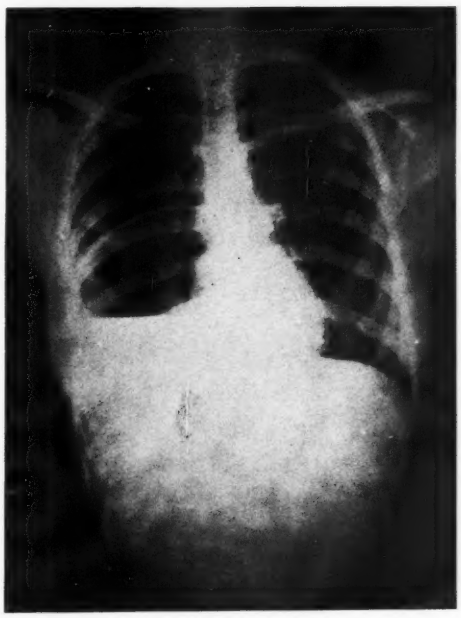

Fig. 2. Patient in upright position.

Autopsy Report.—The body is that of a 17-year-old, slender, colored female, under-nourished. Skin and tissues very dry. Operative wound in the upper right quadrant.

On opening the chest a glistening white sphere about six inches in diameter was seen to occupy the inner lower portion of the right pleural cavity; it collapsed when the herniated opening was released from the abdominal side. When this hernial sac was peeled from the lung to which it was adherent, one could not determine grossly where the peritoneum and pleura separated, the sac itself apparently comprising the sole covering of the lung over the area to which it adhered.

On opening the abdomen the tissues were found to be very dry. The stomach in its distal portion and the proximal six inches of the duodenum showed subserous hemorrhage, most marked at the point of constriction, and the blood vessels in this portion which had been incarcerated

were markedly distended and the surrounding tissues were of a dusky reddish hue. The entire stomach showed distention and vascular congestion. The left lobe of the liver was very dark in color and showed small areas of subperitoneal hemorrhage. The hernial aperture had been tightly closed by sutures, the release of which allowed the sac in the thorax to collapse. The rest of the organs of the abdomen were apparently normal, although the entire small intestines were collapsed and empty.

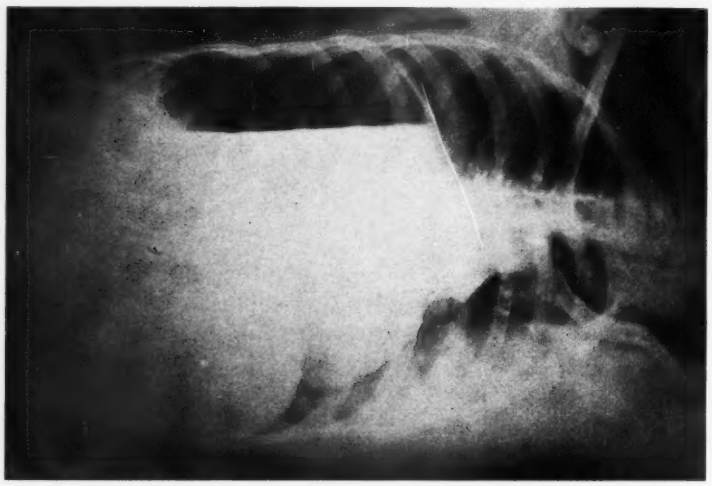

Fig. 3. Patient in lateral recumbent position.

The operative findings and autopsy report both confirm the pre-operative x-ray diagnosis in this case. We have here an unusual type of non-traumatic true hernia which may or may not have been congenital. According to Richards (25), the type with sacculation may or may not be congenital, while according to Harrington (1, 8) the congenital type is usually without a sac, and the type acquired after birth has a sac. The patient gave no history of gastro-intestinal disturbance prior to the acute onset of what was thought to be ptomaine poisoning. Undoubtedly she did have some acute gastric disturbance which caused a distention of the stomach and consequent strangulation through the narrow diaphragmatic opening. At operation, the stomach was found to be considerably distended and injected, but the severity of her symptoms was due to the high intestinal obstruction. None of the barium given at the initial examination passed through the herniated loop of duodenum. The patient was re-examined just before operation—approximately one and a half hours after the diagnosis was established—and up to this time no barium was found in the intestines below the diaphragm. Right-sided herniations, except for the so-called thoracic stomach of LeWald, are rare, and these, of course, are quite rare themselves. In these cases the esophagus is short and the stomach has never been entirely intra-abdominal. We have been unable to locate any case in which the pyloric end of the stomach, together with a small portion of the small intestine only, was herniated in the right side with the fundus remaining in the left abdomen, although we have noted a case, reported by Bridges and Fawcett (23), in which the pre-pyloric end of the stomach was herniated into the *left* side with the fundus remaining in the abdominal cavity.

Even though we are repeating what others have said many times, we wish to emphasize, because of its importance, the necessity of considering the possibility of diaphragmatic hernia in every case in which there is a history of abdominal discomfort or pain, and in which the physical examination reveals signs in the lower part of the chest. Also, in all cases of suspected small intestinal obstruction the possibility of this type of herniation should be considered. In both types of cases, x-ray examination of the chest and gastro-intestinal tract seems to be clearly indicated. A word of caution perhaps should be given in regard to the x-ray diagnosis of this lesion. In cases in which herniation is gross, as was the fact in this particular case, the diagnosis is much easier than when the herniation is small. In such an instance, herniation may be entirely absent with the patient upright or the herniated portion may be obscured by overlying viscera, and unless the patient is examined in all possible positions the herniated viscus may not fill with the opaque medium. Furthermore, as Carman, Fineman, Moore, and Kirklin have pointed out, partial hernia of the stomach, such as was present in this case, when filled with gas and fluid, may closely imitate a hydropneumothorax or an ecchinococcus cyst, or even gas-filled loops of bowel may resemble bronchiectasis, lung abscess, or pluerisy. It should be noted in this case that the preliminary clinical diagnosis was one of hydropneumothorax.

Recently, Dr. Max Weitzen, in an article entitled "Diaphragmatic Hernia with Severe Anemia," has pointed out that obscure cases of secondary anemia may result in patients with diaphragmatic hernia due to petechial hemorrhages arising in the mucosa of the stomach as a result of partial strangulation. It will be noted in the report of this case that the condition of the gastric mucosa was such as to indicate that petechial hemorrhages might have occurred had the patient lived.

Fig. 4. Patient in upright lateral position.

RÉSUMÉ

A case of non-traumatic true diaphragmatic herniation of the pyloric half of the stomach into the right thoracic cavity is reported. The patient was a young female (the majority of cases occur in males), without previous history of gastro-intestinal disturbance. Sickness and death were caused by strangulation of the duodenum, which passed into the chest with the herniated stomach.

The importance of early recognition of herniation of the diaphragm is pointed out, since many of these cases develop strangulation. The rarity of this type of herniation is emphasized.

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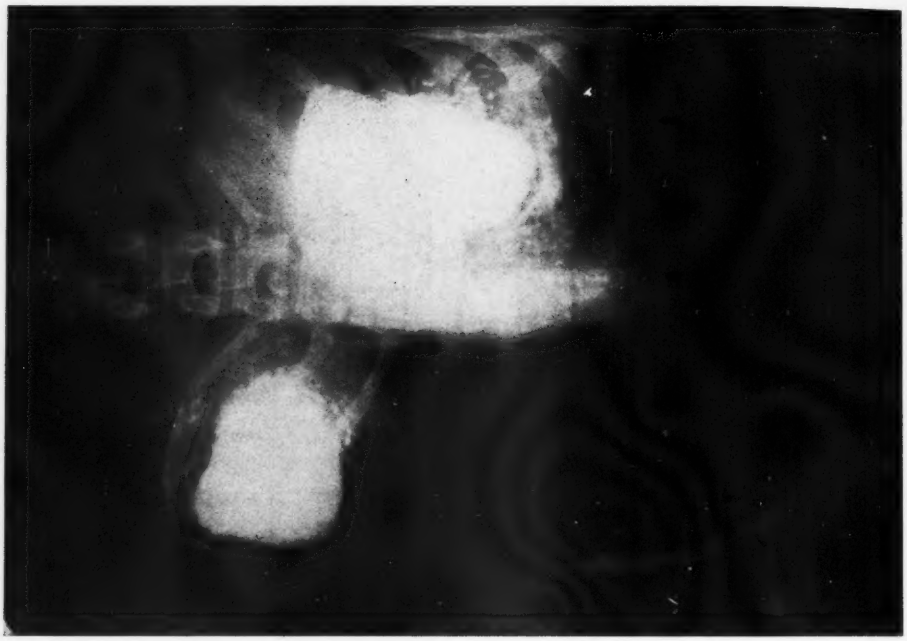

Fig. 5. Patient in supine position.

EDITORIAL

LEON J. MENVILLE, M.D., *Editor* HOWARD P. DOUB, M.D., *Associate Editor*

LAY RADIOLOGY: MEDICAL AND INDUSTRIAL

Medical radiologists all know the necessity for a thorough medical training as a background for the practice of diagnostic as well as therapeutic roentgenology. It is to be hoped that the whole of the medical profession will come to hold fast to this principle. At present we see, however, a minority of doctors who are not so convinced, but who send patients for radiography to non-medical technicians. A great deal has been written and spoken to advance the twin ideals: (1) that physicians should refer their patients for roentgen diagnosis only to medical radiologists, and, (2) that medical radiologists should deserve this by being, as much as possible, well trained and broad-thinking physicians and not merely narrow technical specialists.

The industrial arts are now seen to be using x-rays and radium more and more in inspection of welds, and the gross and fine structure of materials and finished products. It would seem an obvious parallel to the medical ideal of the first paragraph, that such inspection service can be best given by a broadly trained engineer specializing in radiology. To do intelligent radiography of materials one might need as deep an insight into their structure and use as one needs of anatomy and physiology to do intelligent radiography of man.

It would appear, therefore, that a physician radiologist who, because he has an x-ray machine undertakes to do industrial roentgen inspection, is in somewhat the same position as a lay radiographer making roentgenograms of human patients.

The conclusion is that patients should be referred only to a physician, and materials only to an engineer. By adhering to this principle in the industrial case where it means less work for themselves, physician radiologists may make clearer to themselves and others their honesty in promulgating the principle in its application to patients, where it obviously works in the direction of their own self-interest.

ROBERT R. NEWELL, M.D.

"I SERVE"

The closing of another year, and the beginning of a new one would make us all reflect more, were it not that possibly the sum total of our efforts to date seem rather futile and lacking direction. We are afraid of striking a balance for the year, and facing the results.

The years creep by in childhood, but to-day they alarm us by their pace. Our days are passing with hurrying feet and we ask, in despair, "To what end?" Why all this frantic struggle and effort? The essence of our being convinces us that there is something deeply worth while in living, but the facts of our experience somehow tend to make us disappointed.

Possibly, like Barrie, we started out to remake the world, but now, we just pray that the world will kindly leave us in peace. When we left our Alma Mater with diplomas of distinction, did we then feel that life owed it to us to bring further distinction and rewards? There may be something fundamentally weak in our approach to the city of our choice. In these days when values long accepted are being discarded, and the whole world seems upside down, it might be worth our while to re-examine our own foundations, and know whereby we live.

I see in my mind's eye the old royal motto "Ich Dien"—"I Serve." It comes as a challenge to us all. Surely there is something more than merely casting ourselves upon the sea of time and allowing life to drift without direction. Man, so richly gifted, so long adorning, cannot escape the fine endowment of his days. This very motto answers his crying need. To thrust it aside, as betraying sentimentalism, and to be caught up in the pursuit of some by-product of his talent, is to find ultimately nothing but dust and ashes.

The life of the crossing sweeper is more to be envied than that of the man, however richly gifted, who merely accumulates his dues, and, building a wall around his dwelling, shuts off his fellow-man. How pathetic he becomes who judges his success by his bank account, and ends his days by being grateful for a smile from his butler.

The progress of the race has ever been achieved by men who were willing to give everything they had to an ideal. A fully equipped individual, realizing his inmost gifts, makes them of value only in the measure that he is willing to lay them on the altar, and serve his fellow-man.

There is a fine sense of the richness of our high calling when we acknowledge this principle of "I Serve." It challenges our very foundations; it tells us that life is not to be measured, or belittled, in emphasizing our mahogany and silver. There could be no real meaning to such effort and accumulation. Better never to have lived than to have become a mere bin, swallowing up the gains of office and practice.

"I Serve" gives meaning to our daily work. There is nothing but sentimentalism in a principle to which we give only lip service, and to which we devote only our leisure moments.

Observe the tide of life ebbing within some vital spirit. How eagerly he clings to just the privileges of another day! The only endowment he holds sacred is the gift of once again putting his feet firmly upon the ground, and answering the call.

There is no sense in mere gain as an end in itself. What can more property or leisure give us? The game is too strenuous unless, behind it, we feel the impulse for a deeper seriousness, founded upon dedication to service. The real worth of life is our personal contribution. To have reached out and touched our fellow-man; to have served him; never to have failed him, are distinction and thrill enough for any man.

"I Serve" will give direction and meaning to 1934.

W. HERBERT MCGUFFIN, M.D.

COMMUNICATIONS

TEXAS RADIOLOGICAL SOCIETY

Those who attended the successful meeting of the Texas Radiological Society on Jan. 8, at Waco, participated in the following program:

Diaphragmatic Study, with Particular Reference to Infection Beneath It. J. B. JOHNSON, M.D., Galveston.

Duodenal Diverticula. R. K. MCHENRY, M.D., Houston.

The Use of the X-ray in Obstetric and Gynecologic Examinations. DAVIS SPANGLER, M.D., Dallas.

Roentgen Diagnosis of Some Conditions in the Lumbar and Sacral Regions. W. G. MCDEED, M.D., Houston.

Requirements for Qualification as an Expert Radiologic Witness. G. E. HENSCHEN, M.D., Sherman.

Surprises Encountered in Routine Radiologic Practice. DALTON RICHARDSON, M.D., Austin.

Radiologic Management of the Malignant Breast. R. H. MILLWEE, M.D., Dallas.

Further Observations in the Roentgen Treatment of Uterine Fibromyomas. C. P. HARRIS, M.D., Houston.

Benign Uterine Hemorrhage. C. L. MARTIN, M.D., Dallas.

An Evaluation of Cholecystography from 500 Cholecystectomies. R. G. GILES, M.D., Temple.

Address: Radiologic Practice and Responsibility. EDWARD H. SKINNER, M.D., Kansas City, Mo.

AMERICAN REGISTRY OF RADIOLOGICAL TECHNICIANS

The Board wishes to announce that, beginning January 1, 1934, Mr. Alfred B. Greene has been appointed Executive Secretary of the Board. Mr. Greene is also Executive Secretary-Treasurer of the American Society of Radiographers. His address is Glen Lake Sanatorium, Oak Terrace, Minnesota.

IN MEMORIAM

The sad news was received, just before going to press, of the passing on Nov. 30, 1933, of E. D. Crutchfield, M.D., of San Antonio, Texas, a member of this Society. His friends and associates will miss him and the Society will be the poorer for the loss of his contributions to RADIOLOGY.

CAUTION

It has been called to our attention that a certain commercial company which has been offering payment for old films has failed to carry out its agreements with radiologists. If further

details are desired, our readers may inquire of Robert H. Lafferty, M.D., Charlotte Sanatorium, Charlotte, N. C.

BOOK REVIEWS

MANUEL DE RADIODIAGNOSTIC CLINIQUE (Manual of Clinical X-ray Diagnosis). By R. LEDOUX-LEBARD, Chargé de Cours de Radiologie Clinique à la Faculté de Médecine de Paris; Radiologiste des Hôpitaux. Vol. I, pp. 604, with 605 illustrations; Vol. II, pp. 471, with 538 illustrations. Paris: Masson et Cie, 1933. Price: 250 francs, in cloth.

This work is intended to meet the need for a complete and up-to-date text on x-ray diagnosis in the French language for the use of students and practitioners. It is based on the lectures given by M. Ledoux-Lebard as Professor of Clinical Radiology, and on research conducted by him and his students and colleagues. No work on x-ray therapy is included.

The book is in two volumes which consist of eight parts, each one, except the first, being devoted to an anatomical system. A bibliography has been appended to each part and this arrangement is most convenient. The first section deals with the general principles of radiography, but no discussion of the physics of the x-ray is given, since the author feels that this phase has been sufficiently well covered in other texts. There is a clear presentation of the principles underlying the localization of foreign bodies, which is amplified by many good diagrams.

The second section is concerned with bones, joints, and muscles. The usual descriptions of the normal appearance and congenital anomalies are given. The discussion of bone tumors is good, but not very extensive. The other subjects in this section are treated adequately.

The third section, dealing with the head and central nervous system, well covers its subject. The descriptions of the cranium, face, jaws, and teeth are somewhat above the average, while the work on encephalography and myelography is described particularly well.

The fourth part takes up the circulatory apparatus. X-ray examinations of the heart and great vessels in the normal and the pathologic states are well covered and represent one of the best sections of the book. Arteriography and phlebography, which are more recent additions to methods of x-ray examination, are discussed more fully than is found in the average text, and constitute an outstanding feature of this volume. Good visualization of aneurysms is obtained by injecting the abdominal aorta with opaque material. There is an excellent plate showing the lack of circulation in one kidney due to fibrosis produced by tuberculosis, and normal circulation in the opposite kidney brought out by this same method. There is also an excellent demonstration of the increased vascularity in the region of a sarcoma of the upper part of the radius, followed by the decrease in vascularity after x-radiation. These most unusual plates show remarkably well the information that can be obtained by this examination. This method has not been generally adopted in this country, due perhaps to its attendant risks.

The fifth section of the book, dealing with the respiratory system, is a good dissertation on the normal and its variations. The part on acute infections is well done, as is the part on the chronic non-tuberculous respiratory diseases. Lipiodol study of the bronchial tree is particularly good. The great interest in this subject is entirely natural, since lipiodol was first prepared and used by the French. Pulmonary tuberculosis is adequately and completely discussed. The other subjects in this section are also competently presented.

Volume II maintains the high standard of the first volume. The sixth section is devoted to an extensive discussion of the x-ray diagnosis of the normal and pathologic appearance of the gastro-intestinal tract and its appendages. The entire subject is well covered as to text and the illustrations are particularly good. Every condition that one might meet in practice is thoroughly and competently treated. The chapter on duodenal ulcer is one of the outstanding parts of this entire section.

The seventh section dealing with the urinary tract describes adequately the x-ray diagnosis of both normal and pathologic states. While it is rather brief, nothing important has been omitted.

The last part of this volume concerns the genital system and the application of diagnostic x-ray methods to obstetrics and gynecology. There is a complete dissertation on urethrography, which is amplified by good illustrations. Lipiodol is the opaque medium used, indicating again the diverse uses of this substance.

The author's use of lipiodol in gynecological examinations is apparently more extensive than in most places in this country, and shows some strikingly good results. There are excellent illustrations of all the important normal and pathologic conditions, as well as a satisfactory discussion concerning them. The work on obstetrics is brief but covers all of the usual conditions fairly well.

In conclusion, there are a few points which should be emphasized. The text all the way through is written in a simple, easily readable style. The illustrations are of a high order and are probably the most valuable feature of the entire work. The author employs all of the newest methods and is thoroughly conversant with the most recent developments in roentgen diagnosis. This work as a whole is a valuable addition to x-ray literature and fulfills the author's purpose in writing it. A complete mastery of the contents should give one a good grasp of the theory of x-ray diagnosis.

THE 1933 YEAR BOOK OF RADIOLOGY: DIAGNOSIS (Edited by CHARLES A. WATERS, M.D., Associate in Roentgenology, Johns Hopkins University); THERAPEUTICS (Edited by IRA I. KAPLAN, B.Sc., M.D., Director, Division of Cancer, Department of Hospitals, City of New York). Cloth; 804 pages and 780 illustrations. Published by Year Book Publishers, Inc., 1933. Price, $7.00.

The science of radiology has become so involved with the other specialties of medicine that it is almost impossible for even the most ambitious student to keep abreast with the current literature pertaining to it. The 1932 Year Book was hailed as a needed addition to the radiologic literature, but in the present volume the authors have far outstripped their previous efforts. The significant data compiled from 688 important contributions of the past year are presented, together with 780 illustrations. The number of foreign journals reviewed has been considerably increased over the 1932 edition, and the current volume contains references from 125 American and foreign scientific journals. In no other place will one find a better compilation of the latest international developments pertaining to the science of radiology. The text is well arranged, extremely well balanced as to space devoted to the various phases of the subject, and the relation of illustrations to corresponding parts of the text has been improved over the preceding volume. The compilation of this material from the mass of literature pertaining to radiology is no little task and radiologists should be grateful for the untiring efforts of the editors to present the significant current literature of their specialty in a volume that will be looked forward to from year to year.

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ERNST A. POHLE, M.D., Ph.D., of Madison, Wis.
CHARLES G. SUTHERLAND, M.D., Rochester, Minn.

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BONE DISEASES (DIAGNOSIS)

Osteopoikilosis: Case Report. Hugh Jeter and Charles L. McGehee. Jour. Bone and Joint Surg., October, 1933, XV, 990–992.

The authors report a case of osteopoikilosis, which occurred in a white male, 37 years of age. The patient, who was a World War veteran, was examined by means of the x-ray for shrapnel wound of the shoulder. The roentgenogram revealed, besides the metallic foreign bodies, scattered, small, dense areas about the metaphysis and epiphysis of the humerus. The patient stated that the condition had been discovered 14 years previously. X-ray examination of the skeleton showed the presence of similar areas in the bones of the feet, hands, arms, legs, pelvis, and scapulæ. The bones of the spine, ribs, and skull showed no evidence of such changes.

J. N. Ané, M.D.

Bilateral Disease of the Internal Cuneiform Bone, with an Associated Disease of the Right Scaphoid Bone (Köhler's). Edward J. Haboush. Jour. Am. Med. Assn., Jan. 7, 1933, C, 41.

A group of closely related disorders of bone are those known as Legg-Perthes disease of the femoral capital epiphysis, Köhler's disease of the tarsal scaphoid, Osgood-Schlatter's disease involving the epiphysis of the tibial tubercle, Kienböck's disease affecting the semilunar bone of the wrist, and Freiberg's infraction of the second metatarsal head. Most authors are of the opinion that the underlying pathologic condition in these bone disorders is microscopically an aseptic necrosis. Some authorities have observed an infiltration of the bone with fibrous tissue extending from the periosteum. Others have found cystic formation with fibrous tissue infiltration, and some report the changes of an osteochondritis. The author reports a case of bilateral disease of the internal cuneiform, with an associated disease of the right tarsal scaphoid bone (Köhler's). A careful search of the literature failed to reveal any case with similar pathologic changes.

C. G. Sutherland, M.D.

CALCULI

A Case of Renal and Ureteric Calculi of Unusual Size: Repeated Formation of Calculi. Edgar Freshman. British Jour. Surg., July, 1933, XXI, 63–66.

The case reported is an interesting example of "continuous" stone formation in the urinary tract, and illustrates the enormous size that may be attained by calculi before they give rise to symptoms severe enough to induce the patient to seek relief.

The rate at which they were formed in this particular case is worthy of note. All calculi visible on x-ray examination were passed *per urethram* or removed from the left kidney in July, 1923. Four months later two calculi were found in the opposite kidney and one in the bladder. Ten months after this, another, which, according to the symptoms had also come from the right side, was passed and two more were removed from the pelvis of the left kidney, *i.e.*, fourteen months after nephrolithotomy had been performed on that side An interval of nearly six years elapsed before the onset of symptoms suggesting the presence of further calculi. None of the stones had a core of pure uric acid. which might have accounted for the existence of the stones some time before becoming opaque to the x-ray A radiograph demonstrating the renal and ureteric calculi with their measurements and weights accompanies the article.

Davis H. Pardoll, M.D

CANCER (DIAGNOSIS)

A New Method of Roentgenologic Demonstration of Rectal Carcinomas. O. Fricke. Röntgenpraxis, May, 1933, V, 365–368.

Roentgenologic demonstration of rectal carcinomas has been unsatisfactory heretofore and has seemed unnecessary in cases in which the situation and size of the carcinoma could be determined clinically (digital examination, proctoscopy). It is not always possible to get a correct picture of the size and situation of the carcinoma by these clinical methods, and yet for the surgeon these factors are of great importance. The author has devised a simple and effective method of roentgenologic demonstration of such tumors. He fastens a rubber condom on the end of a duodenal tube which has a metallic button on its tip. Enough barium is introduced into the rectum to reach the sigmoid; it is then again aspirated so as to leave just enough to cover the walls of the rectum. The duodenal tube with the non-inflated rubber condom is introduced by means of a wire or a half stiff silk catheter. After the rubber condom has been put in the correct position, it is inflated by air and a roentgenogram is made. Reproductions of such roentgenograms show the location and size of carcinomas nicely. The author believes that the method is of great help for determining the type of operation.

H. W. Hefke, M.D.

CANCER (THERAPY)

Protracted Fractional Roentgen Therapy in Carcinoma of the Female Genital Organs. Heinz Kirchhoff and R. Winckler. Strahlentherapie, 1933, XLVII, 601–626.

The authors report the experience of the Women's Clinic at the University of Kiel with the use of the Coutard treatment method in carcinoma of the uterus and ovary. They used, as a rule, 180 K.V., 4 ma., 2.3 mm. Cu (half value layer in Cu 2.0 mm.), 50–70 cm. F.S.D., 2.2–6 r per minute. Later the filter was reduced to 1.5 mm. Cu. One large area was exposed over the abdomen and two areas over the back. The dose per field amounted to 200 r (in air), or 268 r on the surface. Each skin area was exposed from eight to twelve times, so that most patients received a dose of from 2,400 to 4,000 r effective in the tumor. In this way 220

women were treated, but only 181 are used for these statistics. There were 152 cases of carcinoma of the cervix, 16 carcinoma of ovary, 4 sarcoma, 1 carcinoma of the fundus, 1 of the vagina, 1 of the vulva, 1 of the bladder wall, 4 chorio-epithelioma, and 1 "granulosa cell tumor." In 78 out of 152 patients with carcinoma of the cervix, operation was done in 56, radium treatment in 22. They all were treated by roentgen rays prophylactically. At the time of writing the report, 67 were free of recurrence. Of the remaining 74 cases who had x-ray therapy alone, 19 grew worse under the treatment, 39 did not show any effect at all, 12 were improved temporarily, and 4 definitely at the time of publication.

The observations in the other types of growth were essentially the same. Detailed discussion is devoted to the skin reactions, changes of the blood, and modification of the treatment method. The authors feel that not enough material is really available to justify one in rendering final judgment as to the efficacy of the Coutard method in gynecology. They recommend the application of larger single doses, at least in the beginning of the treatment, and the administration of high total doses, at least 4,000 r effective at the site of the disease. Accurate dosage methods are, of course, essential.

ERNST A. POHLE, M.D., Ph.D.

Critical Report as to the Principles and Results in Roentgen Therapy of Carcinoma of the Stomach and Intestines. Paul Krause. Strahlentherapie, 1933, XLVII, 125–136.

The author analyzes his experience in roentgen treatment of 25 carcinomas of the stomach, 28 carcinomas of the esophagus, 15 carcinomas in the rectum, 9 of the gall bladder, 2 of the liver, and 2 of the pancreas. The technic of the treatment is briefly outlined. Krause has not seen a cure of carcinoma of the stomach by roentgen rays in a single instance. He mentions, however, that Holfelder has reported encouraging results. He observed one sarcoma of the stomach which responded well to irradiation. In carcinoma of the esophagus and rectum, roentgen therapy did not produce cures. Temporary relief was obtained in some cases of carcinoma of the gall bladder and pancreas.

ERNST A. POHLE, M.D., Ph.D.

The Results of Prophylactic Irradiation of Carcinoma of the Breast following Radical Operation. W. Siemens. Strahlentherapie, 1933, XLVII, 627–630.

The author presents the statistics of the Surgical Clinic, University of Kiel, covering their experience with post-operative irradiation of carcinoma of the breast during the period 1908–1929. Out of a total of 508 cases operated upon, 175 were not irradiated and 309 were irradiated. In the statistics, 484 cases are evaluated. Three groups were used, based on clinical examination. In Group I the tumor was limited to the breast; in Group II, *a*, *b*, and *c* graded involvement of glands, skin, and muscles, and Group III included the far advanced cases. It appeared that in Group I prophylactic irradiation did not add anything to the end-results as compared with operation alone. However, in Group II, *a* and *b* (33.6 per cent) were alive after five years with operation alone, while following operation and irradiation 53.2 survived. The author concludes that his clinic will continue to use post-operative irradiation in carcinoma of the breast, and he points out that in his second group, namely, those patients with moderate involvement of the axillary glands, the benefit from the treatment is most striking.

ERNST A. POHLE, M.D., Ph.D.

The Radiation Treatment of Intra-oral Cancer. C. W. Prowd. Canad. Med. Assn. Jour., February, 1933, XXVIII, 182–184.

In actual practice present-day conditions call for close co-operation between radiation therapists and surgeons in the treatment of intra-oral cancer.

The first consideration is intra-oral asepsis, radium and x-ray treatment of mouth conditions being doomed to failure in the presence of mouth infection. Warning should be given the patient of the period of reaction, lasting from six to eight weeks. The cheeks and anterior half of the tongue are accessible to radium element or radon seed implantation from within or without. The floor of the mouth we have found to respond better to topical applications than radium implants. This is true also of the under surface of the tongue and the gums. Electro-coagulation immediately follows radiation. The tonsils, pharynx, and soft palate are best treated by radon seeds or radium element.

All cases of tongue, floor of mouth, tonsil, and pharyngeal cancers are given supplementary x-ray to the submaxillary areas and neck triangles. This treatment should be pre- and post-radium.

The author records 156 cases of oral carcinoma observed over a period of six years (1926–1931). Of these, 45 (28.8 per cent) had palpable submaxillary glands on one or both sides, and 78, or exactly 50 per cent of all cases, are dead. No case with involved glands lived more than three years.

L. J. CARTER, M.D.

Radiation in Primary Operable Breast Cancer. Douglas Quick. Jour. Am. Med. Assn., Dec. 30, 1933, CI, 2091–2096.

Until recently, radiation has been limited to post-operative therapy and to the palliative care of inoperable, recurrent, and metastatic growths. In only a limited way has there been a close co-operation between surgery and radiation therapy in the field of breast cancer. There is now sufficient reliable published information and an accumulation of experience to warrant a reappraisal of the situation. Accumulated experience is sufficient to warrant advancing of the status of radiation in the breast group. It deserves initial consideration in the entire primary operable group—not in a competitive but in a co-operative way. Strictly oper-

able tumors in elderly persons may well be a problem for radiation therapy rather than for surgery. The same may be true for the very young. Advanced growths, still considered operable by many surgeons, will probably do better by radiation than by surgery. When the evidence is carefully gone over, the fact remains that of all patients coming to operation at least 70 per cent are dead from extension of the disease at the end of five years, and that the majority of the remaining 30 per cent die of cancer ultimately. It seems evident that radiation therapy should be pressed more aggressively in the so-called operable stages of breast cancer, rather than limited to the follow-up phase of therapy. Continued study, correlation of the microscopic changes with the clinical reaction to radiation, will go far toward pointing out those groups most amenable to radiation therapy. In early breast cancer there seems little doubt but that roentgen radiation occupies the major position. Radium occupies a limited, but valuable place, and always for implantation. Occasionally, a primary tumor assigned wholly to radiation requires implantation and, at operation, radium by implantation may frequently be used to advantage in the axilla or the upper intercostal spaces adjacent to the sterum. For these purposes, radon in gold seeds affords a wide range of flexibility in application and is much less damaging from the standpoint of trauma. Radium or radon implantation should always follow rather than precede the roentgen irradiation. While the ovarian hormone evidently exerts an influence on the development of some breast cancers, there is no substantial evidence to warrant castration by radiation as a therapeutic aid. Biopsy is safe if carefully done after preliminary radiation. The same degree of attention should be given to technical detail in radiation therapy as in surgery.

C. G. SUTHERLAND, M.D.

CONTRAST MEDIA

Hazards of Iodized Oil Injections. Editorial. Jour. Am. Med. Assn., Jan. 7, 1933, C, 46.

Sometimes the possibilities of hazard inherent in a new method have been dimmed by the promising diagnostic aid for the primary pathologic condition. As medical experience has matured, the limitations of the roentgen ray and radium are becoming more and more circumscribed; inexperienced use of these potent forms of energy brought early unfortunate accidents and death to members of the profession. It has been ten years since the iodized oils were introduced as diagnostic agents. Experience has proved that injection and retention in the body of these oils are not without danger. Accidents have occurred—some serious, a few fatal. Tuberculous lesions are often unduly irritated; embolic phenomena have been noted; inflammatory reactions are not infrequently induced by the retained oil. The reports of the Council on Pharmacy and Chemistry emphasize the insistence on due caution in the use of all new methods and preparations until their potentialities for doing damage have been subjected to the test of scientific scrutiny.

C. G. SUTHERLAND, M.D.

DIAPHRAGMATIC HERNIA

Diaphragmatic Hernia. W. H. Dickson. Canad. Med. Assn. Jour., July, 1933, XXIX, 24–31.

The symptoms and physical signs of diaphragmatic hernia are so indefinite that clinical diagnosis is very rare. Griffin, in 1912, collected the reports of 650 cases, of which only 12 were correctly diagnosed during the patient's lifetime.

Coincident with the application of radiology to the gastro-intestinal tract all the varieties of diaphragmatic hernia have been shown to be of frequent occurrence.

Hernia of the stomach through the hiatus esophagei constitutes the largest group. It is both congenital and acquired, the congenital being the more common form. Other abnormalities which may be confused with it are diverticula at the lower end of the esophagus and diverticula at the cardiac end of the stomach. The next most frequent variety is through the left diaphragm. The only source of error is eventration of the left diaphragm. Hernia of the right diaphragm is rare—when this lesion is suspected a pneumoperitoneum must be done. A defective embryologic development of the hepatic flexure may be a source of error in such a case.

L. J. CARTER, M.D.

DOSAGE

Clinical Experimental Observations Concerning the Fractional Dose Method in Irradiation of Cancer. F. Keller. Strahlentherapie, 1933, XLVII, 636–645.

The author studied the effect of fractional doses on the skin of mice by applying daily $^1/_3$ H.E.D. He could administer two and one-third times the dose which would epilate if applied in a single sitting. The treatment of tumors in animals was not markedly successful. Quite striking was the systemic reaction of the animals treated with fractional doses. An attempt to use this treatment method clinically was not successful, more complications being seen thus than after the usual method of administration. His experience is based on five patients with carcinoma of the cervix.

ERNST A. POHLE, M.D., Ph.D.

Comparison of Skin Reactions under Different Methods of Administration. R. Pape. Strahlentherapie, 1933, XLVIII, 73–96.

According to the author the skin reactions depend chiefly on four factors. (1) The total dose; (2) the number of r per minute administered; (3) the total time of treatment; (4) the number of fractional doses. He studied experimentally one special case, namely, the equivalent doses for a fractional application consisting of two sittings and a single dose, both producing the same skin reactions. It appeared that the reactions were equal if the total duration of the exposures was proportional to the number of r per minute applied in each case.

ERNST A. POHLE, M.D., Ph.D.

ESOPHAGUS (DIAGNOSIS)

A Case of Polyps in the Esophagus. N. A. Podkaminsky. Röntgenpraxis, May, 1933, V, 353, 354.

A 29-year-old man complained of inability to swallow, gradually getting worse during two years. Roentgenologic examination of the esophagus showed a narrowing in its cardiac portions by a smooth, well circumscribed tumor. Infiltration of the wall of the esophagus could not be demonstrated. Barium passed into the stomach only after a half-hour. Above the narrowing the esophagus widened. Because of the youth of the patient, the long history of dysphagia, and the roentgenologic signs a benign tumor of the esophagus was suspected—and proven by esophagoscopy. Five benign polyps of the mucoid type were removed.

H. W. HEFKE, M.D.

ESOPHAGUS (THERAPY)

Development of Diverticula of the Esophagus following Roentgen Therapy of Intrathoracic Tumors. Arnold Herzog. Strahlentherapie, 1933, XLVII, 795–797.

The author observed two patients in whom definite traction diverticula developed following roentgentherapy applied to the chest for neoplasm of the lung or the mediastinum. The histories of these cases are briefly given, and roentgenograms show the diverticula. The author suggests the study of cases of this type, combined with search for traction diverticula.

ERNST A. POHLE, M.D., Ph.D.

A Rubber Esophagus. London letter quoting Arthur Edmunds. Jour. Am. Med. Assn., April 29, C, 1352.

A case is reported in which a rubber tube was substituted for a large part of the esophagus, with almost complete restoration of function. The patient was a woman, aged 40, from whom had been removed the larynx, part of the pharynx, the cervical esophagus, and a considerable part of the thoracic esophagus for squamous-cell carcinoma. The operation necessitated a permanent tracheotomy and a gastrotomy. By establishing a pharyngeal sinus in the neck just below the hyoid bone, the surgeon was able to introduce the short end of a wide rubber empyema tube into the upper pharynx. This tube was made secure in the neck by tapes passing through the holes in the flanges, and was connected by a long rubber tube with the gastrotomy opening, thus producing an external rubber esophagus. The device functioned well and no secondary growths followed.

Now, 23 years after the operation, the patient is alive and well and able to enjoy life. She complains only that, if she catches cold, the coughing upsets her and produces some chafing at the entrance of the tube into the stomach. The tubes are taken out regularly and boiled, and there is no unpleasantness from decomposing food. She can wear a dress that entirely conceals her condition from observers. She has, of course, lost her voice, but she has cultivated a whisper which is sufficient for social intercourse. She is able to take and masticate ordinary food, both solid and liquid, and to swallow it through the rubber esophagus.

C. G. SUTHERLAND, M.D.

THE FOOT

The Prehallux in Relation to Flatfoot. F. C. Kidner. Jour. Am. Med. Assn., Nov. 11, 1933, CI, 1539–1542.

The prehallux, or accessory scaphoid, is a common and frequently unrecognized anomaly which, by changes in the leverage, interferes with the normal mechanics of the action of the posterior tibial muscle and thus produces weakness of the longititudinal arch and flatfoot of a type highly resistant to the usual conservative methods of treatment. In the presence of the prehallux, whether as a separate bone or as a prolongation inward of the scaphoid, there is an abnormal insertion of the tibialis posticus tendon. It has been found that in many cases of flatfoot in which the prehallux is absent the same abnormal course of the posterior tibial tendon is seen. In the presence of the prehallux, the outward excursion of the scaphoid on the head of the astragalus is increased, so that the motion of the astragaloscaphoid joint is abnormally great, producing what is, in effect, an outward subluxation of the whole forefoot or an inward subluxation of the anterior end of the astragalus. This leads to a considerable increase of ligament strain, with marked pain and foot weakness.

C. G. SUTHERLAND, M.D.

FOREIGN BODIES

Needles in the Deep Urethra; Stone and Peri-urethral Abscess: Case Report in 7-year-old Boy. Meredith Campbell. Am. Jour. Surg., September, 1933, XXI, 452, 453.

Masturbation in children by the introduction of foreign bodies into the urethra is not uncommon but seldom is the stimulant object lost in the canal. The following case is of interest because two long darning needles were thus deposited in the deep urethra of a 7-year-old boy, yet it is reported because it admirably illustrates: (1) the usual complications of urethral foreign body; (2) the likelihood that the erroneous diagnosis of gonorrhea will be made, and (3) the type of treatment required when the foreign body is large or peri-urethral suppuration exists.

DAVIS H. PARDOLL, M.D.

FRACTURES (THERAPY)

Fractures of the Ankle: Recent and Old. Melvin S. Henderson and Walter G. Stuck. Jour. Bone and Joint Surg., October, 1933, XV, 882–888.

The authors reviewed the histories of all cases with fracture of the ankle treated in the Orthopedic Section of the Mayo Clinic from 1909 to 1933, consisting of 479

patients, of whom 139 had recent fractures of the ankle and 340 had old fractures.

This statistical study shows in particular the great importance of early diagnosis and recognition of the extent of injury and early accurate reduction, followed by careful and adequate immobilization. This is particularly true in the "trimalleolar" fracture, first described by one of the authors.

The "trimalleolar" fracture consists of the clinical Pott's fracture, plus fracture of the posterior malleolus, with encroachment on the weight-bearing surface of the astragalus. This is usually accompanied by posterior and upward dislocation of the astragalus, manifested clinically as posterior displacement of the foot.

The treatment of recent fractures should be as conservative as possible. Malleolar fractures without displacement should be treated by splinting or strapping. In cases of deformity, manipulation and immobilization in a plaster cast are indicated.

Roentgenograms should be made in two planes before and after reduction. After reduction the anteroposterior view should show the normal convexity of the tibia fitting accurately into the normal concavity of the astragalus. In the lateral view the convexity of the superior surface of the astragalus should fit the concave articular surface of the tibia accurately.

Among the 340 patients with old fracture of the ankle who came to the Clinic because of pain, swelling, limitation of motion, deformity, or weakness, it is interesting to note that in many cases roentgenograms had not been made, either at the time of the accident or later. The authors believe that this omission was due to inaccessibility of roentgen-ray equipment and unwillingness of patients to submit to the examination.

J. N. Ané, M.D.

GALL BLADDER (NORMAL AND PATHOLOGIC)

Persisting Errors in the Technic of Oral Cholecystography: A Procedure Designed to Avoid Them. B. R. Kirklin. Jour. Am. Med. Assn., Dec. 30, 1933, CI, 2103–2105.

The author has become thoroughly convinced that when the oral method is properly executed, its efficiency is equal to that of the intravenous method and that adverse comparisons of the two methods are based usually on results derived from faulty oral technics. To employ the oral test effectively, the dye must be given: (1) in sufficient quantity; (2) in readily absorbable form; (3) in such a manner that it will not produce undue nausea or purgation, and (4) under conditions that will not hamper its evacuation from the stomach, its absorption from the bowel, or its accumulation and concentration in a normal gall bladder. Sodium tetraiodophenolphthalein (tetiophthalein) is given in a uniform dose of 4 gm. to adults, reduced for children in proportion to weight, but not varied for small or large adults. The compound is given in solution, freshly prepared, in such a manner that it will be palatable and well borne by the stomach. The most satisfactory method has been to mix it with grape juice, other fruit juices, or carbonated water. The most important factor, in his experience, has been the settling on a fixed routine of requiring the patient to take a full meal containing a minimum of fat and following it immediately with the dye. Much fat in the meal will lead to a high proportion of mistakes in diagnosis. To avoid interference with absorption of the dye or with its entrance into and concentration by the gall bladder, purgatives, especially castor oil, and other medicines which affect the intestine or biliary organs, should not be taken by the patient during or shortly prior to the examination. Cleansing of the large bowel is best effected by having the patient employ enemas on the morning of examination.

A review of the cholecystographic data for the year 1932 shows that of 732 patients operated on, the cholecystographic diagnosis, whether positive or negative, was confirmed in 95 per cent.

C. G. Sutherland, M.D.

Dietary and Medical Management of Diseases of the Gall Bladder: Newer Points of View. John Russell Twiss and Carl H. Greene. Jour. Am. Med. Assn., Dec. 9, 1933, CI, 1841.

A critical review of the literature on the anatomy, physiology, chemistry, and pathology of the liver and biliary tract, summarizing new points of view for the study of the disease process, the developments of new technical methods of examination, or advances in any of the medical sciences, prefaces this discussion.

The function of the gall bladder is to provide a reserve of concentrated bile, of value both in digestion and as a means of stimulating the liver to increased activity at the time the gastro-intestinal tract is most active. An extensive experimental literature indicates that the gall bladder perhaps never empties completely, as does the urinary bladder, and several days may elapse before the entire contents at any one particular time is removed. The question of the mechanism involved in the emptying of the gall bladder into the duodenum embraces the effect of respiratory movements, changes in intra-abdominal pressure, the elasticity of the viscus, variations in the tonus of the duodenal wall or of the sphincter of Oddi, and the existence of a reciprocal innervation between the sphincter and the gall bladder.

If medical therapy is ever to supplant surgery in this field of medicine, it will be necessary to recognize and correct disturbances in the biliary tract before the formation of calculi. Various predisposing causes to be considered are: biliary stasis; infective disturbances in pigment excretion or cholesterol metabolism; obesity and pregnancy. The authors have found non-surgical biliary tract drainage a valuable supplementary method of diagnosis, provided the drainage is properly performed and the results are correctly interpreted. The general plan of medical treatment is considered under the headings of (1) prevention of biliary stasis; (2) prevention or treatment of inflammation of the gall bladder or bile ducts; (3) diet, and (4) removal of calculi when once formed. Progress other than surgical in the

last has been *nil*. A series of tables detail the various forms of diet used in types of cases.

C. G. SUTHERLAND, M.D.

GASTRO-INTESTINAL TRACT (DIAGNOSIS)

The Intestine as an Excretory Organ. Editorial. Jour. Am. Med. Assn., April 22, 1933, C, 1253.

Recently physiologists have begun to realize the importance of the bowel as an organ of excretion: by this is meant not the removal of materials that have failed to be digested and absorbed. The feces also contain substances secreted into the lumen of the intestine for excretory purposes. This applies notably to iron, calcium, and magnesium as well as to certain foreign elements. The large intestine may be regarded as the principal channel for the excretion of insoluble substances that cannot be easily passed out by the kidneys.

Williams and Dick have pointed out that the excretion of water by the intestine has long been recognized as a useful therapeutic procedure, but little emphasis has been placed on the substances excreted with the liquid. The action of the saline cathartics is generally regarded as being due to the large amount of liquid that is abstracted from the blood through the intestinal mucosa by the hypertonic solution. According to them, appreciable amounts of the non-protein nitrogen metabolites are eliminated in the stools by purgation. The higher the concentration of non-protein nitrogen in the blood, the higher is the concentration in the liquid feces. The therapeutic efficacy of vigorous catharsis and purging is supported by experimental evidence. Sometimes the concentration of nitrogen in the purgation stools was greater than that in the blood. In any event, new interest has become centered in the possible value of the saline cathartics and hydragogues in the treatment of chronic nephritis and chronic myocarditis.

C. G. SUTHERLAND, M.D.

Congenital Obstruction of the Small Intestine. William E. Ladd. Jour. Am. Med. Assn., Nov. 4, 1933, CI, 1453–1458.

This is a study of 60 cases occurring in the Children's Hospital of Boston. Only those cases were included in which the obstruction was located in the small intestine and was due to one of two factors: Intrinsic obstruction is the interference in the continuity of the lumen of the intestine due to intra intestinal defects, while extrinsic obstruction is the interference in the function of the intestine by external pressure due to faulty rotation. Obstruction caused by bands which may or may not be of congenital origin and that due to hernias and the vagaries of Meckel's diverticulum were not included. The normal embryologic development of the intestine is discussed, with the results of arrest in development during this period and the variety of conditions presented in extrinsic obstruction due to faulty rotation. Roentgen examinations, with and without the administration of contrast media, are of great assistance in diagnosis. The point of obstruction, if complete, is clearly identified by the outline of the gas above the blind end. The administration of barium is contra-indicated if one suspects a complete obstruction. Reports of typical cases are given in detail.

C. G. SUTHERLAND, M.D.

Treatment of Acute Intestinal Obstruction by Suction with the Duodenal Tube. Owen H. Wangensteen and John R. Paine. Jour. Am. Med. Assn., Nov. 11, 1933, CI, 1532–1539.

In this essay on the treatment of acute intestinal obstruction by suction with the duodenal tube a clinical classification is charted with that of the pathologic and the treatment of the various forms. The contra-indications to the use of this form of treatment are outlined. The x-ray film is an aid of value not only in determining the presence of obstruction but also in deciding its location, as well as in the decision as to whether the obstruction is complete or incomplete. The visualization of gas in the small bowel of the adult is synonymous with stasis. A single x-ray film taken with the patient supine gives more information than plates taken in any other position. It reveals the grade of intestinal distention present and affords fairly reliable evidence as to its location. Roentgen studies made with an enema of barium sulphate are unnecessary and are contra-indicated in acute obstructions except in intestinal atresia and in cases in which the conjectured presence of an obstruction in the descending colon would appear to need verification by an enema of barium sulphate.

In a patient having intestinal colic in whose bowel the distention involves, and is limited solely to, the colon, the diagnosis of obstruction in the descending colon is practically established. If loops of small intestine are distended but gas is also present in the colon, the patient in all likelihood has a partial obstruction of the small intestine. Distention of the small intestine alone without visible gas in the colon means that the obstruction is complete. From inspection of the roentgen film of the abdomen, one cannot predict the exact location of an obstruction in the small intestine with the same precision as in the colon. On the whole, however, it may be determined with fair accuracy whether the obstruction is in the upper, lower, or middle third of the small intestine.

C. G. SUTHERLAND, M.D.

GASTRO-INTESTINAL TRACT (THERAPY)

Retrograde Intussusception of Jejunum. Ralph B. Bettman and Robert S. Baldwin. Jour. Am. Med. Assn., April 22, 1933, C, 1128.

The authors have been able to find 32 cases on record, exclusive of the one here reported, of this condition complicating gastro-enterostomy. The American literature contained only five case reports. Following a gastro-enterostomy twelve years previously their

patient had been in excellent condition until six days previously, when, after a full day's work of heavy manual labor, he experienced a sharp pain in the upper abdomen. The pain was quite severe, but was relieved when he vomited. In a few hours the pain returned with such severity that he was hospitalized. He continued to vomit and in a few hours the vomitus contained bright red blood and later became feculent. After five days' expectant treatment he was transferred to the surgical group and a laparotomy was performed. A retrograde intussusception of 120 cm. was found, starting in the efferent jejunal loop of the anastomosis about 30 cm. from the stomach, and extending through the gastro-enterostomy into the stomach itself. The intussusception was readily disinvaginated, but the intestine was found to be gangrenous. A portion of the bowel was exteriorized and a jejunostomy was done. The patient continued in poor condition and died two days later.

A review of the literature follows, which shows that early operation consisting of simple reduction of the intussusception was successful in over 90 per cent of the cases.

C. G. SUTHERLAND, M.D.

GENITO-URINARY TRACT (DIAGNOSIS)

Hemipyonephrosis in Infants and Children. Meredith Campbell. Am. Jour. Surg., July, 1933, XXI, 85–96.

Five cases of hemipyonephrosis in very young children are reported. Being anomalous, reduplicated kidneys are more prone to disease than are normal organs. The condition illustrates another lesion which may cause persistent urinary infections in juveniles and, because of pyuria, commonly leads to the diagnosis of chronic pyelitis. The correct diagnosis of hemipyonephrosis is made by urologic examination. When half of the double kidney remains undiseased, and the operation is technically feasible (the condition of the patient permitting) ureteroheminephrectomy is the treatment of choice. With marked renal infection, especially acute, nephrectomy is often the wiser course. In the youngest patient of this series, ureteroheminephrectomy was successfully performed at the age of six months. Several pyelograms and illustrative drawings accompany the article.

DAVIS H. PARDOLL, M.D.

Intravenous Urography in the Diagnosis of Rupture of the Bladder. Ernest G. Mark. Jour. Am. Med. Assn., Jan. 7, 1933, C, 42.

In the gathered statistics of de Tarnowsky it is quite definitely shown that when a diagnosis has been made and operative procedure instituted within the first 12 hours following injury, the mortality has been approximately 11 per cent: postponed for 24 hours, the mortality has risen to 55 per cent. The innocuousness of the more recent media for intravenous urography suggested their use in the diagnosis of a ruptured bladder in this writer's case. Thirty-five c.c. of 40 per cent skiodan was given intravenously while the patient was on a Bucky diaphragm table. Roentgenograms at seven minutes and fifteen minutes after injection showed an extra-peritoneal rupture into the space of Retzius, with an extavasation most marked on the left. Immediate operation substantiated the diagnosis and repair was made. The post-operative course up to 11 days later was uneventful.

C. G. SUTHERLAND, M.D.

Vascular Obstruction of the Ureter in Juveniles. Meredith Campbell. Am. Jour. Surg., December, 1933, XXII, 527–541.

Seven proved cases and one probable instance of vascular ureteral obstruction in juveniles are reported. Loin pain is a frequent symptom. When infection, with pyuria, exists, "chronic pyelitis" is the usual diagnosis. When infection is slight or absent, the clinical diagnosis, based on urinalysis, is likely to be chronic interstitial nephritis. The existent hephritis is regularly of the toxic variety in the unobstructed organ and of the compression or back-pressure type in the obstructed kidney. This nephritis may be expected to disappear following removal or adequate treatment of the seriously diseased mate. Only by complete urologic examination with urography can an accurate diagnosis be made pre-operatively. Conservation surgery, chiefly vessel resection or ureteroplasty, is urged, while nephrectomy is indicated in cases of far-advanced renal destruction, infection, or calculus disease. By specific example, these cases serve to emphasize the great importance of early diagnosis and treatment of persistent urinary tract disease in young patients.

Many interesting roentgenograms and reproductions of pathologic specimens accompany the article.

DAVIS H. PARDOLL, M.D.

GENITO-URINARY TRACT (THERAPY)

Urachal Cysts and Fistulæ. Marion Douglass. Am. Jour. Surg., December, 1933, XXII, 557–560.

The author reports two cases in which it seems likely that injury to the urachus was the condition responsible for the midline wound infection, which persisted, apparently without cause, over a long period of time. The generalization may be made that very slight urinary leakage may be responsible for similar lesions and for hernias occurring in obscurely infected wounds as well. It seems worth while, therefore, in making gynecologic incisions, if the urachus cannot be pushed to one side or the other and is not clearly obliterated, especially at its lower portion toward the bladder, that it should be picked up and if there is the slightest question of its possible patency, should be ligated firmly.

DAVIS H. PARDOLL, M.D.

GYNECOLOGY AND OBSTETRICS

Dilatation of the Kidney Pelvis and Ureter during Pregnancy and the Puerperium. Herman L. Kretschmer, N. Sproat Heaney, and Eugene A. Ockuly. Jour. Am. Med. Assn., Dec. 23, 1933, CI, 2025.

The authors studied a series of cases by intravenous pyelography, selecting only such women as gave normal kidney and bladder histories and who were normal as to urinary examinations and obstetric conditions at the time. Thirty-one cases were followed from early pregnancy through the delivery and the puerperium until the kidney and ureteral conditions were normal. At some time during pregnancy, dilatation was found in 97.6 per cent of the group. One patient showed a mild dilatation of the calices and lumbar ureter on the left side ten days after delivery, so, therefore, 100 per cent showed evidence of dilatation at some time during pregnancy or after delivery.

The striking feature about the dilatation of the ureter during pregnancy was that the dilatation was almost universally above the brim of the pelvis. As a rule, the dilatation is progressive, along with the pregnancy. Lateral displacement of the ureter, when found early in pregnancy, tends to increase as the pregnancy advances. In none of these cases did pyelitis develop during pregnancy, although marked dilatation and lateral displacement were present. Presentation and position of the fetus could not be brought into causative relationship with dilatation or displacement.

C. G. SUTHERLAND, M.D.

Roentgen Rays in the Diagnosis of Placenta Prævia. London letter quoting Munro Kerr and W. G. Mackay. Jour. Am. Med. Assn., Feb. 25, 1933, C, 587.

The authors first injected strontium iodide into the amniotic sac. The fetus died in three of ten cases. The authors then substituted a derivative of iopax, non-toxic and non-irritant, and found that 20 c.c. would produce a suitable shadow. In ten cases, no untoward effects occurred to either the fetus or the mother, though the injection had a great tendency to terminate the pregnancy. It was necessary to take at least two roentgenograms, one anteroposterior and the other lateral, to be sure of getting a full view of the indentation made by the placenta. In placenta prævia the roentgenograms showed how much of the placenta was in the lower segment and covered the os. It was also shown that in certain cases the sex of the child could be diagnosed and the film also showed whether or not any coils of cord were round the child's neck.

C. G. SUTHERLAND, M.D.

HEART AND VASCULAR SYSTEM

Cardiac Roentgenoscopy. M. C. Morrison. Canad. Med. Assn. Jour., July, 1933, XXIX, 51–55.

The x-ray has provided two chief methods of study of the heart—roentgenoscopy and teleroentgenography. The author discusses the former.

The roentgenoscopic examination of the heart provides a method of ascertaining cardiac mobility, and also permits, through the orthodiagraph or fluoroscopic tracing, an accurate record of cardiac size and movement. The experienced observer is permitted to study the force, tone, co-ordination, organization, and the presence of excessive or insufficient motion. He can also determine the intrinsic motion of the various chambers, and the transmitted motion of the heart as a whole, together with its relations to the other structures of the chest.

L. J. CARTER, M.D.

The Roentgenologic Diagnosis of Calcification of the Heart. G. W. Parade and F. Kuhlmann. Röntgenpraxis, May, 1933, V, 341–346.

Roentgenologic observation of calcification in pericardium and myocardium has been reported rather often. A diagnosis of calcification in the connective tissue of the heart, however, during life appears to be rare. According to Giese, who studied these calcifications from an anatomic-pathologic standpoint (with roentgenograms of postmortem hearts), calcification is most common in the sclerotic tissue at the base of the mitral valve, the so-called annulus fibrosus—the sclerotic portion of the aortic valves. These calcifications are predominantly found in old persons and are degenerative processes. Calcification on an inflammatory base is much rarer. Simmonds was the first author to demonstrate these changes roentgenologically, and a few other authors have reported similar cases.

Three patients with calcification of the mitral-ring and one case of calcification of the aortic valve were observed by the authors. This latter is, so far as the authors know, the first such case diagnosed roentgenologically during the life of the patient. In all cases the calcification was not homogeneous, but irregular and nodular, like a string of pearls. The calcification of the aortic valves showed a ringlike arrangement in the authors' case.

Fluoroscopic examination is necessary in order to locate the calcified areas. They seem to move almost horizontally toward the left and a little downward with the beginning of the systole; at the end of the systole they move upward and return to the original position during the diastole. The calcified aortic valve moved toward the base of the heart during diastole, the extent of its movement being considerably less than that of the calcified mitral valve. In one case autopsy proved the roentgenologic diagnosis.

H. W. HEFKE, M.D.

Coarctation of the Aorta: Ten Years' Observation of a Patient Still Living. M. J. Shapiro. Jour. Am. Med. Assn., March 4, 1933, C, 640–642.

Coarctation of the aorta is a term used to designate a narrowing or complete obliteration of the aorta, usu-

ally in the region of the insertion of the ligamentum arteriosum, the vestigial ductus botalli, distal to the origin of the subclavian artery. There are two forms: infantile and adult. The former represents a persistence of intra-uterine circulation and is incompatible with life. The adult form consists of a sharp narrowing, even to the extent of complete obliteration, in the immediate vicinity of the insertion of the ductus botalli. The diagnosis is made on four characteristic observations: hypertension of the upper extremities, lowered or absent blood pressure of the lower extremities, evidence of collateral circulation, and erosion of the ribs as demonstrated by roentgen examination. The erosion is caused by the dilated and tortuous intercostal arteries, which carry the brunt of the collateral circulation made necessary by the narrowing or complete obliteration of the aorta. Enlargement of the heart, especially of the left ventricle, is quite common but may not be present. The roentgenogram shows the erosion and scalloping of the ribs.

C. G. SUTHERLAND, M.D.

HEMATURIA

An Investigation of 742 Cases of Hematuria. R. K. Debenham. British Jour. Surg., July, 1933, XXI, 44–62.

In analyzing 742 cases of hematuria the author has arrived at the following conclusions: In men the most frequent causes of bleeding are papilloma and carcinoma of the bladder, while in women inflammatory conditions of the urinary tract seem to be the most prevalent cause. When hematuria is the presenting symptom in men the chances are that it is due to either papilloma or carcinoma of the bladder in 50 per cent of the cases. It seems, however, in women the cause is as likely to be inflammatory as neoplastic. When hematuria occurs as an only symptom (65 cases), there is a two-to-one chance that it may be due to the same condition as above, whereas in women (10 cases) the commonest causes was renal calculi.

The prostate assumes the leading rôle as a common cause of hematuria in men at the age of fifty or beyond. Illustrative of the above may be cited the following: In 130 cases of hematuria in men over sixty years of age, 43 per cent were suffering from papilloma or carcinoma of the bladder, and 37 per cent from either simple or malignant enlargement of the prostate. Not infrequently both carcinoma of the bladder and prostatic enlargement are associated. The symptoms in some cases are rather similar and unless cystoscopy is performed a case may for a time be considered to be one of prostatic enlargement, resulting in the loss of valuable time.

When hematuria is classified according to the various decades of life it is found that the first and second are relatively free of bleeding. Inflammatory conditions and calculi are most frequently found as a cause in both sexes during the second and third decades. Neoplasm becomes the commonest cause of hematuria in men in the fifth decade of life and in both sexes in the sixth decade.

Carcinoma of the kidney is rare—it was the cause of only 2.5 per cent of all the reported upon cases of hematuria and was found six times oftener in men than in women. Not uncommonly painless hematuria may be caused by renal calculi. The diagnosis of hematuria due to varicose vesical veins must be made with great caution, unless the bleeding is actually seen to be coming from a varix. It is imperative that a cystoscopy be done during the attack of bleeding in order to determine, if possible, the source. On the other hand, best results in cases suggestive of carcinoma vesicæ, with foul urine containing much blood, are usually obtained after several days in bed and lavage of the bladder.

Of the 66 cases of unexplained hematuria, 49 were traced, and the subsequent history and findings disclosed that, of these, four cases (8 per cent) reported that calculi had been either passed or removed; 33 (67 per cent) were almost well, no more bleeding having occurred; eight (16 per cent) reported recurrence of bleeding on one or more occasions. All were well or only slightly inconvenienced except one man who had syphilis and had become blind; and four (8 per cent) had died, two of acute lung conditions unassociated with the hematuria, one of carcinoma of the prostate eight years after his attendance at the hospital, and one of stroke.

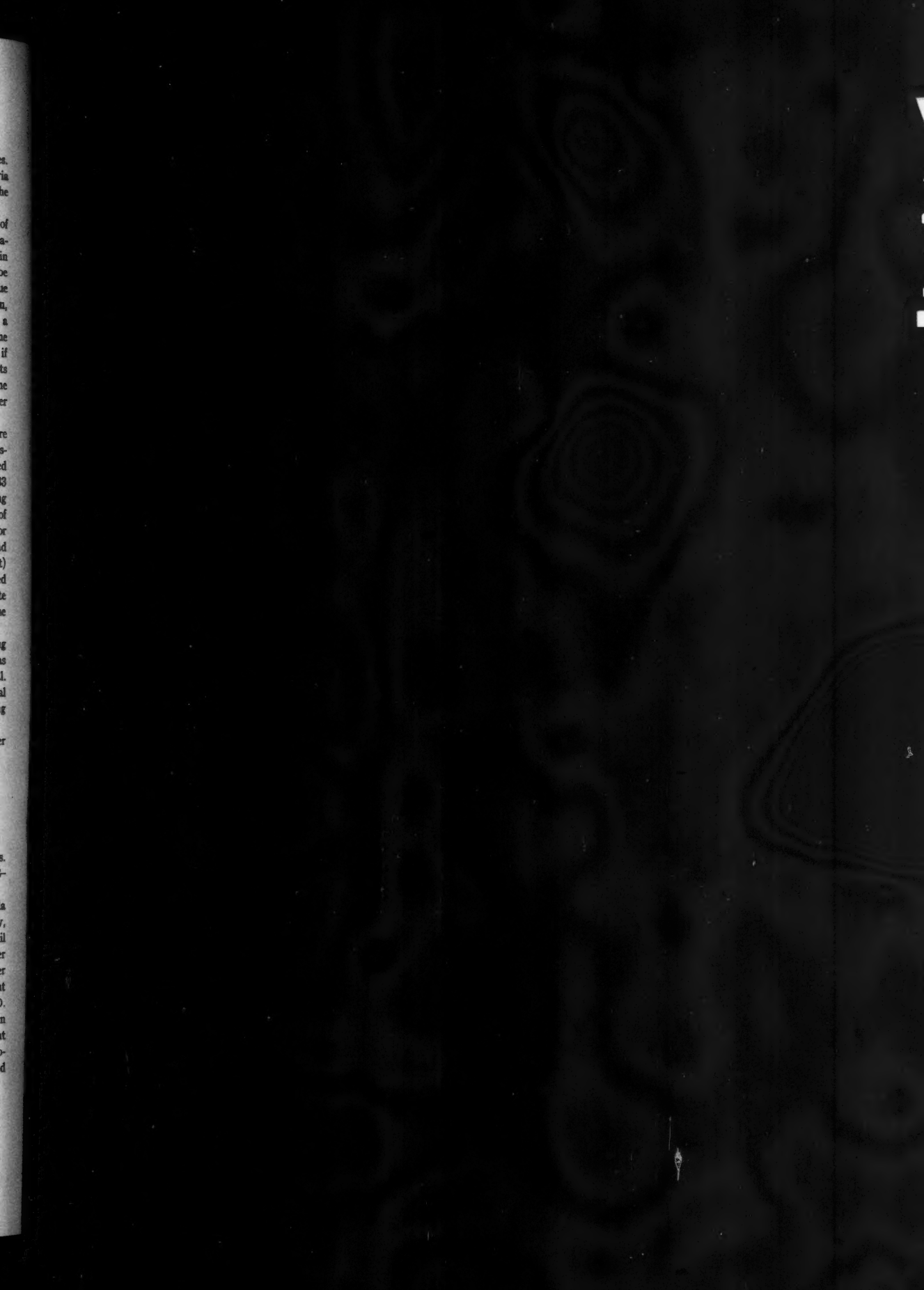
The most difficult cases to diagnose are those giving few symptoms other than the hematuria, which has ceased by the time the patient reaches the hospital. Cases of unexplained hematuria fall into several different catagories; the prognosis is good if nothing abnormal can be found on full urologic investigation.

Several graphs and charts accompany this rather interesting statistical article.

DAVIS H. PARDOLL, M.D.

THE KIDNEY

Destroying the Kidney Function by Roentgen Rays. Ernst Navratil. Strahlentherapie, 1933, XLVII, 348–358.

Klein suggested the treatment of cases with fistula of the ureter by roentgen irradiation of the kidney, in sufficient doses to destroy the function. Navratil tried this in a number of cases; one received 240 per cent H.E.D. during 3 weeks, the second case 240 per cent H.E.D. in 2 series, a third case 150 per cent H.E.D. in 7 weeks, a fourth case 100 per cent H.E.D. in 18 days, and a fifth case 130 per cent H.E.D. within one week. In not a single instance was the treatment successful. Three kidneys could be examined histologically after removal; no changes could be found which might be attributed to the roentgen exposure.

ERNST A. POHLE, M.D., Ph.D.